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PRESIDENT OF THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, 1890-1891.

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NORTH OF ENGLAND INSTITUTE

OF

MINING AND MECHANICAL ENGINEERS.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

ANNUAL GENERAL MEETING,
HELD IN THE WOOD MEMORIAL HALL, NEWCASTLE-UPON-TYNE,
AUGUST 1ST, 1903.

SIR LINDSAY WOOD, BART., RETIRING PRESIDENT, IN THE CHAIR.

DEATH OF EARL RAVENSWORTH.

The RETIRING PRESIDENT (Sir Lindsay Wood, Bart.) said that Earl Ravensworth was elected a patron of the Institute in 1877, and had therefore held that office for more than a quarter of a century. He sat in the House of Commons as Lord Eslington from 1852 to 1878, and during that time he had rendered great assistance to the Coal-trade during the discussion and passing through the House of the many important Bills which affected that trade. His opinions on such matters were always respected by both sides of the House, whichever government was in power and it was largely due to his assistance and influence that the Institute obtained from H.M. the late Queen Victoria, the honour of a Royal Charter in 1876.

The SECRETARY read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on July 18th and that day, and of the Council of The Institution of Mining Engineers.

ELECTION OF OFFICERS, 1903-1904.

The Retiring President appointed Messrs. George May, John Simpson, W. B. Wilson, junr. and J. Kirsopp, junr., as scrutineers of the balloting-papers for the election of officers for the year 1903-1904.

The Scrutineers afterwards reported the result of the ballot, as follows:—

President:
Mr. W. O. Wood.

Vice-Presidents:

Mr. R. D. Bain.	Mr. W. C. Blackett.	Mr. W. Logan.
Mr. C. Berkley.	Mr. T. E. Forster.	Mr. J. H. Merivale.

Councillors:

Mr. R. S. Anderson.	Mr. H. Lawrence.	Mr. M. W. Parrington.
Mr. B. Dodd.	Mr. C. C. Leach.	Mr. J. Shiel.
Mr. M. H. Douglas.	Prof. H. Louis.	Mr. F. R. Simpson.
Mr. T. Y. Greener.	Mr. J. Morison.	Mr. J. Simpson.
Mr. J. K. Guthrie.	Mr. J. H. Nicholson.	Mr. R. F. Spence.
Mr. T. E. Jobling.	Mr. H. Palmer.	Mr. R. L. Weeks.

The Chairman (Sir Lindsay Wood, Bart.) moved, and Mr. J. C. B. Hendy seconded, a vote of thanks to the scrutineers for their services, and it was cordially approved.

Mr. Thomas Douglas (Darlington) moved a vote of thanks to the Retiring President, Vice-Presidents and Councillors, and to the representatives of the Institute on the Council of The Institution of Mining Engineers for their services during the past year. The President (Sir Lindsay Wood, Bart.) had rendered valuable services to the Institute during his term of office. The Jubilee celebrations of the Institute had imposed upon the President very onerous duties and responsibilities, and he had carried them out with the utmost satisfaction to the members.

Mr. A. L. Steavenson (Durham), in seconding the vote of thanks, referred to the advance which had been made in mining science during the last 50 years. The objects, which the father of their Retiring President—the late Mr. Nicholas Wood—in conjunction with the other gentlemen who assisted him in found-

ing the Institute had in view, had been very fully carried out, and he hoped that the next 50 years might see an equal advance.

The vote of thanks was cordially adopted.

The RETIRING PRESIDENT, in acknowledging the vote of thanks, said that he felt sure the Institute was doing good work and was carrying out the wishes of its founders.

The Annual Report of the Council was read as follows:—

ANNUAL REPORT OF THE COUNCIL, 1902-1903.

The Jubilee of the Institute was celebrated in the Wood Memorial Hall on September 16th, 1902. The members were received by the President, Sir Lindsay Wood, Bart., who delivered an address; and at his invitation, a conversazione was held in the Museum of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne, by permission of that Society. A large number of members and representatives from other societies attended.

The Institution of Mining Engineers held their Annual General Meeting in Newcastle-upon-Tyne on September 17th, 18th and 19th, in conjunction with the Jubilee Meeting of this Institute. The large number of members present necessitated the congress being held in two sections. The best thanks of the members are due to the committee who made the arrangements, to the owners of collieries and works open for inspection, and to all those who by their services contributed to the holding of that successful meeting.

The following table shows the progress of the membership during the past few years:—

Year ending August 1st.	1893.	1898.	1903.
Honorary Members	25	30	26
Members	565	859	921
Associate Members	47	115	112
Associates	47	103	161
Students	34	51	69
Subscribers	22	22	23
Totals	740	1,180	1,312

The members are to be congratulated upon the increase in the membership of the Institute:—155 members of all classes

have been added to the register during the past year, and after allowing for losses by deaths and resignations, there is a net increase of 74 members.

The Library has been maintained in an efficient condition during the year; the additions by donation, exchange and purchase, include 449 bound volumes, 123 pamphlets, reports, etc.; and the Library now contains about 9,392 volumes and 2,763 unbound pamphlets. A card-catalogue of the books, etc., contained in the Library renders them readily available for reference.

Members would render useful service to the profession, by presentations of books, reports, plans, etc., to the Institute, to be preserved in the Library and available for reference.

The courses of lectures for colliery-engineers, engine-wrights and apprentice-mechanics have been continued at the Durham College of Science. The lectures are delivered on Saturday afternoons, and the three years' course embraces the following subjects:—

1903-1904. Michaelmas Term, (1) Mensuration, and (2) the Chemistry of Fuel. Epiphany Term, (3) Strength of Materials, and (4) Experimental Mechanics.

1904-1905. Michaelmas Term, (5) Theoretical Electricity, and (6) Electrical Engineering. Epiphany Term, (7) Steam-engines and Boilers, and (8) Haulage and Winding.

1905-1906. Michaelmas Term, (9) Transmission of Power, and (10) Pumping and Ventilation. Epiphany Term, (11) Metallurgy of Iron and Steel, and (12) Mining Machinery (mainly machinery used underground).

Several colliery-owners have paid the fees (£1 10s. 0d. per annum) and railway expenses of pupils attending the classes from their collieries. During the past year, the lectures of the Michaelmas Term on the Transmission of Power were attended by 61 students, and Pumping and Ventilation by 65 students, 52 sat for examination and 39 passed; and during the Epiphany Term, the lectures on the Metallurgy of Iron and Steel were attended by 61 students, and Mining Machinery (chiefly used underground) by 59 students, 43 were examined and 28 passed. Prizes were awarded to Messrs T. H. Bolton and J. H. Thompson. Certificates have been awarded to the following students who have completed the three years' course:—Messrs. T. H. Bolton, G. T. Hughes, S. Hutchinson, H. Nicholson and R. D. Oswald.

A loyal and dutiful address was forwarded to His Majesty, King Edward the Seventh, and Her Majesty Queen Alexandra, on the occasion of Their Majesties' Coronation on August 9th, 1902.

The G. C. Greenwell bronze medal has been awarded to Mr. A. A. Atkinson (H.M. Inspector of Coal-mines, New South Wales), for his paper upon "Working Coal under the River Hunter, the Pacific Ocean and its Tidal Waters, near Newcastle, in the State of New South Wales."*

The Council have decided to publish a supplementary volume to *An Account of the Strata in Northumberland and Durham, as proved by Borings and Sinkings*, and members are desired to send copies of any unpublished sections on strata in these counties, or their section-books, to the secretary on loan. A small tracing from the 6 inches Ordnance Map, showing the position of any shaft or bore-hole, if not already fixed by previous publications, will greatly facilitate the work.

Mr. John Daglish continues to represent the Institute as a governor of the Durham College of Science, which was jointly founded in 1871 by the University of Durham and the North of England Institute of Mining and Mechanical Engineers. Mr. T. E. Forster, in conjunction with the President (Sir Lindsay Wood, Bart.), represents the Institute on the Council of the Durham College of Science.

Mr. J. H. Merivale will again represent the Institute at the Conference of the Corresponding Societies of the British Association for the Advancement of Science, to be held in Southport, commencing on September 9th, 1903. Mr. W. Cochrane represents the Institute upon the Board of Directors of the Institute and Coal Trade Chambers Company, Limited.

The representatives of the Institute upon the Council of The Institution of Mining Engineers during the past year were as follows:—Sir Lowthian Bell, Bart., Sir David Dale, Bart., Sir Lindsay Wood, Bart., and Messrs. William Armstrong, John Batey, T. W. Benson, Bennett H. Brough, A. G. Charleton, John Daglish, T. E. Forster, William Galloway, John Gerrard, Reginald Guthrie, Philip Kirkup, C. C. Leach, Henry Louis, George May, John Morison, M. W. Parrington, R. A. S. Redmayne, A. R. Sawyer, J. B. Simpson, John G. Weeks and W. O. Wood.

An exchange of *Transactions* has been arranged, during the year, with the Cuerpo de Ingenieros de Minas del Perú.

* *Trans. Inst. M.E.*, 1902, vol. xxiii., page 622.

Prizes of books have been awarded to the writers of the following papers communicated to the members during the year 1901-1902:—

"A Method of Socketing a Winding-rope, and its Attachment to a Cage without the Use of Ordinary Chains." By Mr. W. C. Blackett, M.I.M.E.

"Mechanical Undercutting in Cape Colony." By Mr. John Colley, M.I.M.E.

"Electric Pumping-plant at South Durham Collieries." By Mr. Fenwick Darling, M.I.M.E.

"Some Silver-bearing Veins of Mexico." By Mr. Edward Halse, M.I.M.E

"Apparatus for Closing the Top of the Upcast-shaft at Woodhorn Colliery." By Mr. C. Liddell, Stud.I.M.E.

"A Visit to the Simplon Tunnel: the Works and Workmen." By Dr. Thomas Oliver.

"The Carboniferous Limestone Quarries of Weardale." By Mr. A. L. Steavenson, M.I.M.E.

"Auriferous Gravels and Hydraulic Mining." By Mr. W. S. Welton, M.I.M.E.

"Tapping Drowned Workings at Wheatley Hill Colliery." By Mr. W. B. Wilson, jun., M.I.M.E.

The papers printed in the *Transactions* during the year are as follows:—

"Working a Thick Coal-seam in Bengal, India." By Mr. Thomas Adamson, M.I.M.E.

"The Use of Carboniferous Plants as Zonal Indices." By Mr. E. A. Newell Arber.

"The Gases enclosed in Coal and Coal-dust." By Prof. P. Phillips Bedson, Hon. M.I.M.E.

"Improved Offtake-socket for Coupling and Uncoupling Hauling-ropes." By Mr. W. C. Blackett, M.I.M.E.

"Description of the Lead-ore Washing-plant at the Greenside Mines, Patterdale." By Mr. Wm. H. Borlase, M.I.M.E.

"Granite-quarrying, Sett-making and Crushing; and the Manufacture of Concrete-flags and Granitic Tiles." By Mr. Geo. H. Bragg.

"The Gases enclosed in Coal." By Dr. Broockmann.

"The Gypsum of the Eden Valley." By Mr. D. Burns, M.I.M.E.

"Sinking by the Freezing Method at Washington, County Durham." By Mr. Mark Ford, M.I.M.E.

"The Crumlin Meteorite." By Principal H. Palin Gurney, Hon. M.I.M.E.

"Some Silver-bearing Veins of Mexico." By Mr. Edward Halse, M.I.M.E.

"Air-compression by Water-power: The Installation at the Belmont Gold-mine." By Mr. D. G. Kerr, M.I.M.E.

"Ambulance-instruction at Mines." By Mr. William Leck, M.I.M.E.

"The Occurrence of Gold in Great Britain and Ireland." By Mr. J. Malcolm Maclaren, M.I.M.E.

"Report of the Delegate to the Conference of Delegates of Corresponding Societies of the British Association for the Advancement of Science, Belfast, 1902." By Mr. J. H. Merivale, M.I.M.E.

"Some of the Considerations affecting the Choice of Pumping Machinery." By Messrs. A. H. Meysey-Thompson, M.I.M.E., and H. Lupton.

"Treatment of Low-grade Copper-ores." By Dr. Edward Dyer Peters.
"A Measuring-tape, and its Use in Mine-surveying." By Mr. S. J. Pollitzer, M.I.M.E.
"The Underlay-table." By Mr. S. J. Pollitzer, M.I.M.E.
"The Geology of the English Lake District." By Mr. J. Postlethwaite.
"The Utilization of Exhaust-steam by the Combined Application of Steam-accumulators and Condensing Turbines." By Prof. A. Rateau, M.I.M.E.
"The Max Electric Mining Lamp." By Mr. E. Roubier.
"The Valuation of Gas-coals." By Mr. James Stewart.
"Hæmatite-deposits and Hæmatite-mining in West Cumberland." By Mr. W. E. Walker, M.I.M.E.
"Address." By Sir Lindsay Wood, Bart., M.I.M.E.

Excursions have been made to the Newbottle Collieries of the Lambton Collieries, Limited, and to mines and works in the neighbourhood of Cleator Moor, Keswick, Whitehaven and Workington, and the thanks of the members have been accorded to the owners of these mines and works.

The Committee appointed to "investigate and report on labour-saving machines and tools used in cutting and boring coal and rock" will shortly issue their first report.

The Coal-mines Regulation Act (1887) Amendment Act, which has recently received Royal assent, will enable the holder of a diploma in scientific and mining training, after a course of study of at least two years, at any University, University College, Mining School or other Educational Institution, to be approved of by a Secretary of State, or of a degree of any University to be so approved of, which includes scientific and mining subjects, after having had practical experience in a mine for at least three years, to sit for a Certificate of Competency as Manager or Under-manager under the Coal-mines Regulation Act, 1887.

The Retiring President (Sir Lindsay Wood, Bart.), in moving the adoption of the report of the Council, hoped that the Institute would for many years be able to present such satisfactory reports.

Mr. Thomas Douglas seconded the resolution, which was unanimously agreed to.

The Report of the Finance Committee was read as follows:—

REPORT OF THE FINANCE COMMITTEE.

The Finance Committee submit herewith a statement of accounts for the twelve months ending June 30th, 1903, duly audited.

The total receipts were £2,888 5s. 2d. Of this amount, £69 18s. was paid for life-compositions in lieu of annual subscriptions, and £78 10s. as subscriptions in advance, leaving £2,739 17s. 2d. as the ordinary income for the year, compared with £2,675 16s. 6d. in the previous year.

The total expenditure was £3,726 4s. 4d., as compared with £2,443 9s. 4d. for the previous year. The principal item in this increase is the sum of £1,006 3s. paid on account of the alterations to the Lecture Theatre: £118 2s. 11d. was expended in connection with the Jubilee Meeting, and £42 4s. on behalf of the Coal-cutting Committee: medals costing £67 8s. 4d. have been purchased out of the Greenwell Prize Fund; and the contributions to The Institution of Mining Engineers show an increase of £104 5s. 9d., due to the larger membership. From the figures shown above, it will be seen that the total expenditure during the year exceeded the income by £837 19s. 2d., and deducting this amount from the balance in hand at the beginning of the year, there is a sum of £169 7s. 10d. to carry forward. There still remains about £160 to be paid in connection with the alterations and furnishing of the Lecture Theatre, and this will be met out of the revenue for the ensuing year.

The names of 38 persons have been struck off the membership-list, in consequence of non-payment of subscriptions. The amount of subscriptions written off was £160 14s., of which £81 8s. was for sums due during the year ending June 30th, 1903, and £79 6s. for amounts which had fallen due in previous years. The recovery of these amounts has been placed in the hands of the solicitors, and the amounts obtained by them will be placed to the credit of the account in future years.

JOHN G. WEEKS.

August 1st, 1903.

The RETIRING PRESIDENT (Sir Lindsay Wood, Bart.) moved the adoption of the report of the Finance Committee.

Mr. J. G. WEEKS seconded the resolution, which was unanimously adopted.

General Statement, June 30th, 1903.

Liabilities.

	£	s.	d.	£	s.	d.
Subscriptions paid in advance during the current year	78	10	0			
Ditto. in previous year	4	4	0			
	82	14	0			
The Institution of Mining Engineers ...	30	3	11			
Printing	24	8	8			
				137	6	7
The George Clementson Greenwell Prize Fund £100 0 0						
Less—Paid for Medals ... 67 8 4						
	32	11	8			
Mr. Clarence R. Claghorn: Prize for Essay	10	0	0			
				42	11	8
Capital				11,298	19	1
				£11,478	17	4

We, having examined the above account with the books, vouchers and securities relating thereto, certify that, in our opinion, it is correct. We have accepted the assets, books, pictures, maps, etc., and *Transactions* and other Publications as valued by your Officials.

JOHN G. BENSON AND SONS,
Chartered Accountants.

Newcastle-upon-Tyne,
August 1st, 1903.

Assets.

	£	s.	d.	£	s.	d.
Balance of Account at Bankers	103	5	7			
„ in Treasurer's hands	61	9	6			
Author's Excerpts	4	12	9			
				169	7	10
Arrears of Subscription				306	4	0
179 Shares in the Institute and Coal-trade Chambers Company, Limited (at cost) ...	4,100	0	0			
Investment with the Institute and Coal-trade Chambers Company, Limited (Mortgage)...	1,400	0	0			
				5,500	0	0
(Of the above amount, £1,484 is due to Life Subscriptions Account.)						
Value of *Transactions* and other Publications, as per Stock Account				353	5	6
Books, Pictures, Maps, Furniture and Fittings				5,150	0	0
				£11,478	17	4

DR. THE TREASURER IN ACCOUNT WITH THE NORTH OF ENGLAND FOR THE YEAR ENDING

June 30th. 1902.							£	s.	d.	£ s. d.
To Balance at Bankers							949	17	6	
,, ,, in Treasurer's hands							56	8	6	
,, Outstanding Accounts due from Authors for Excerpts							1	1	0	
										1,007 7 0
June 30th, 1903.										
To Dividend of 7½ per cent. on 179 Shares of £20 each in the Institute and Coal-trade Chambers Company, Limited, for the Year ending June 30th, 1903				£268	10	0				
Less—Repaid on purchased Shares ...				9	0	0				
							259	10	0	
,, Interest on Mortgage of £1,400 with the Institute and Coal-trade Chambers Company, Limited							49	0	0	
										308 10 0
To Sale of *Transactions*										18 9 2
To SUBSCRIPTIONS FOR YEAR 1902-1903 AS FOLLOWS :—										
726 Members			@ £2 2s.				1,524	12	0	
83 Associate Members			@ £2 2s.				174	6	0	
105 Associates			@ £1 5s.				131	5	0	
59 Students			@ £1 5s.				73	15	0	
77 New Members			@ £2 2s.				161	14	0	
3 New Members (not yet elected) ...			@ £2 2s.				6	6	0	
16 New Associate Members			@ £2 2s.				33	12	0	
30 New Associates			@ £1 5s.				37	10	0	
28 New Students			@ £1 5s.				35	0	0	
							2,178	0	0	
23 Subscribing Firms							96	12	0	
							2,274	12	0	
To LIFE COMPOSITIONS :—										
1 Member				£24	0	0				
2 New Members				45	18	0				
							69	18	0	
							2,344	10	0	
Less—Subscriptions for Current Year paid in advance at the end of Last Year							106	12	0	
							2,237	18	0	
Add—Arrears received							244	18	0	
							2,482	16	0	
Add—Subscriptions paid in advance during the Current Year							78	10	0	
										2,561 6 0
										£3,895 12 2

INSTITUTE OF MINING AND MECHANICAL ENGINEERS. CR.
JUNE 30TH, 1903.

June 30th, 1903.	£	s.	d.	£	s.	d.
By Annual Report	35	6	9			
„ Banker's Charges	21	9	10			
„ British Association for the Advancement of Science: Expenses of Delegate	8	6	7			
„ Circulars, etc.	48	8	5			
„ Cleaning Wood Memorial Hall, Offices, etc.	37	19	6			
„ Coal-cutting Committee	42	4	0			
„ Electric Light and Gas	45	15	10			
„ Expenses of Jubilee Meeting, etc.	118	2	11			
„ Fire Insurance	12	13	10			
„ Fuel	18	12	0			
„ Furniture and Repairs	48	5	0			
„ George Clementson Greenwell Prize Fund: Medals	67	8	4			
„ Incidental Expenses	8	12	5			
„ Lecture Theatre: Alterations	1,006	3	0			
„ Library—Binding £67 12 9						
„ „ Books 37 16 10						
	105	9	7			
„ Petty Cash	3	9	10			
„ Postages—Circulars £35 9 0						
„ „ Correspondence 19 15 8						
„ „ Publications 24 2 9						
	79	7	5			
„ Prizes for Papers	22	1	0			
„ Rates and Taxes	6	8	3			
„ Rent of Offices	24	7	10			
„ Reporting of General Meetings	12	12	0			
„ Salaries, Wages, Auditing, etc.	487	17	4			
„ Stationery, etc.	24	10	10			
„ Subject-Matter Index	84	8	5			
„ Telephone Rent	2	17	0			
„ Translations of Papers	2	15	6			
„ Travelling Expenses	1	3	0			
„ Typewriter	21	7	0			
„ Water Rate	4	12	4			
				2,402	15	9
By The Institution of Mining Engineers	1,328	12	10			
Less—Amount paid by Authors for Excerpts	5	4	3			
				1,323	8	7
				3,726	4	4
By Balance at Bankers	103	5	7			
„ „ in Treasurer's hands	61	9	6			
„ Outstanding Accounts due from Authors for Excerpts	4	12	9			
				169	7	10

We, having examined the above account with the books and vouchers relating thereto, certify that, in our opinion, it is correct.

JOHN G. BENSON AND SONS.
CHARTERED ACCOUNTANTS.

Newcastle-upon-Tyne, August 1st, 1903.

£3.895 12 2

DR. THE TREASURER IN ACCOUNT

	£ s. d.	£ s. d.
To 893 Members.		
48 of whom have paid Life Compositions.		
845		
6 not included in printed list.		
851 @ £2 2s.		1,787 2 0
1 Member paid Life Composition		24 0 0
To 109 Associate Members.		
8 of whom have paid Life Compositions.		
101		
1 of whom has paid as a New Member.		
100 @ £2 2s.		210 0 0
To 122 Associates,		
3 of whom have paid as New Members.		
119		
2 not included in printed list.		
121		
1 of whom has paid Life Composition.		
120 @ £1 5s. . ..		150 0 0
To 66 Students @ £1 5s.		82 10 0
To 23 Subscribing Firms		96 12 0
To 77 New Members @ £2 2s.		161 14 0
To 2 New Members who have paid Life Compositions		45 18 0
To 3 New Members, not yet elected		6 6 0
82		
To 16 New Associate Members @ £2 2s.		33 12 0
To 30 New Associates @ £1 5s.		37 10 0
To 28 New Students @ £1 5s.		35 0 0
		2,670 4 0
To Arrears, as per Balance Sheet 1901-1902	319 3 0	
Add—Arrears considered irrecoverable, but since paid...	66 19 0	
		386 2 0
		3,056 6 0
To Subscriptions paid in advance		78 10 0
		£3,134 16 0

WITH SUBSCRIPTIONS, 1902–1903. CR.

		PAID. £ s. d.	UNPAID. £ s. d.	STRUCK OFF LIST. £ s. d.
By 726	Members, paid ... ... @ £2 2s.	1,524 12 0	.....	.....
By 97	,, unpaid ... @ £2 2s.	.....	203 14 0	.....
By 2	,, dead ... ... @ £2 2s.	.....	.....	4 4 0
By 26	,, struck off list @ £2 2s.	.....	.....	54 12 0
851				
By 1	Member, paid Life Composition	24 0 0	.....	.....
By 83	Associate Members, paid @ £2 2s.	174 6 0	.....	.....
By 11	,, ,, unpaid @ £2 2s.	.....	23 2 0	.....
By 6	,, ,, struck off list ...	.....	.....	12 12
100				
By 105	Associates, paid ... ... @ £1 5s.	131 5 0	.....	.....
By 8	,, unpaid ... @ £1 5s.	.....	10 0 0	.....
By 7	,, struck off list @ £1 5s.	.....	.....	8 15
120				
By 59	Students, paid ... ... @ £1 5s.	73 15 0	.....	.....
By 6	,, unpaid ... @ £1 5s.	.....	7 10 0	.....
By 1	,, struck off list @ £1 5s.	.....	.....	1 5 0
66				
By 23	Subscribing Firms, paid	96 12 0	.....	.....
By 77	New Members, paid ... @ £2 2s.	161 14 0	.....	.....
By 2	New Members, paid Life Compositions	45 18 0	.....	.....
By 3	New Members, not yet elected, paid ... . @ £2 2s.	6 6 0	.....	.....
82				
By 16	New Associate Members, paid @ £2 2s.	33 12 0	.....	.....
By 30	New Associates, paid ... @ £1 5s.	37 10 0	.....	.....
By 28	New Students, paid ... @ £1 5s.	35 0 0	.....	.....
		2,344 10 0	244 6 0	81 8 0
By Arrears	... ...	244 18 0	61 18 0	79 6 0
		2,589 8 0		
By Subscriptions paid in advance	... ...	78 10 0	.....	.....
		2,667 18 0	306 4 0	160 14 0
				306 4 0
				2,667 18 0
				£3,134 16 0

REPRESENTATIVES ON THE COUNCIL OF THE INSTITUTION OF MINING ENGINEERS, 1903-1904.

The Retiring President (Sir Lindsay Wood, Bart.) moved, and Mr. J. K. Guthrie seconded a resolution, that the following gentlemen be elected as the representatives of the Institute on the Council of The Institution of Mining Engineers for the year 1903-1904:—

Mr. William Armstrong.	Mr. Reginald Guthrie.	Mr. John Morison.
Mr. John Batey.	Mr. T. E. Jobling.	Mr. Henry Palmer.
Mr. T. W. Benson.	Mr. Philip Kirkup.	Prof. R. A. S. Redmayne.
Mr. Bennett H. Brough.	Mr. C. C. Leach.	Mr. H. Richardson.
Mr. W. Forster Brown.	Mr. William Logan.	Mr. J. B. Simpson.
Mr. J. S. Burrows.	Prof. Henry Louis.	Mr. A. L. Steavenson.
Mr. John Daglish.	Mr. J. H. Merivale.	Mr. John G. Weeks.
Mr. T. E. Forster.	Mr. C. A. Moreing.	Mr. Gardner F. Williams.

The resolution was agreed to.

The following gentlemen were elected, having been previously nominated:—

Members—

Mr. Charles Ernest Alger, Mechanical and Electrical Engineer, 160, Dock Street, Newport, Monmouthshire.

Mr. Gilbert Frederick Archer, Mechanical Engineer and Draughtsman, 11, Regent Terrace, Gateshead-upon-Tyne.

Mr. William Black, Mining Engineer, 39, Crossfield Road, Cleator Moor, Cumberland.

Mr. Louis P. Bowler, Mine-manager and Engineer, Axim, Gold Coast, West Africa.

Mr. Edwin Henry Green, Mechanical Engineer, P.O. Box 1978, Johannesburg, Transvaal.

Mr. Richard Hartley, Mining Engineer, 46, Lowther Street, Whitehaven.

Mr. Charles Edward Hope, Engineer, Vancouver, British Columbia.

Mr. Joseph Musgrave Kearney, Mining Engineer, 53, Market Place, Whitehaven.

Mr. Eliah George Pamplin, Engineer, Cherryhinton, Cambridge.

Mr. Robert William Pringle, Mining Engineer, c o the Rev. J. C. Pringle, All Saints' Rectory, Poplar, London, E.

Mr. Thomas Shewan, Colliery Manager, Saint Hilda Colliery, South Shields.

Mr. Edmund Bessell Whalley, H.M. Inspector of Mines, Edinburgh.

Mr. Thomas Hughes Williams, Colliery Manager, Tynedale Colliery, Hexham.

Mr. Thomas P. Yeoman, Mining Engineer, Government Collieries, Warora, Central Provinces, India.

ASSOCIATE MEMBERS -

Mr. SCOTT GUNN, 18, John Street, Sunderland.

Mr. EUGENE HAANEL, Department of the Interior, Ottawa, Ontario, Canada.

Mr. SAMUEL THOMPSON, P.O. Box 15, Greytown, Natal, South Africa.

STUDENTS -

Mr. ALBERT EDWARD DOUGLAS, Mining Student, Usworth Hall, County Durham.

Mr. ALFRED POTTS, Mining Student, Esh Colliery Office, near Durham.

DISCUSSION OF MR. H. D. D. BARMAN'S PAPER ON "THE RIEDLER PUMP."*

Mr. A. L. STEAVENSON (Durham) said that the Riedler pump was a well-designed machine, and the only difficulty that he saw in connection with it was with reference to the conditions under which it should be used. Under all circumstances he was strongly opposed to the introduction of steam underground, and there was now no necessity for this, in view of the other methods of conveying power by means of electricity, compressed air and endless ropes, though, no doubt there might be exceptional circumstances under which boilers, cased in brickwork, might be used. He thought that it would be an advantage for engineers to distinguish between the terms plungers and rams:—He thought that "ram" should be used in the case of a solid body of metal going into a cylinder, and "plunger" for a double-acting piston. He asked whether Mr. Barman could give the useful effect of each pump described in his paper, that is:—How did the work in the water lifted compare with the power of the engine? It was stated that the volume of the water was in one instance somewhat more than the displacement of the pump. This was by no means unusual: some years ago he tested an ordinary bucket-pump, and found that the water brought to the surface exceeded the swept-volume. This might be accounted for by the fact that when the end of the stroke was reached, the water owing to its *vis viva* continued to flow, if the pumps were kept in good order. In a seam, where the lift did not exceed 150 feet, he preferred especially if working with electricity, to to use a centrifugal pump from which the flow was continuous. About 30 to 60 feet used to be the limit of height with a centrifugal pump, but, by modern improvements, this was greatly

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 238.

exceeded. He first saw them when, as a boy, he visited the Great Exhibition of 1851. He would be pleased to show any of the members one of these high-lift centrifugal pumps working at a mine with which he was connected. He agreed with the writer of the paper that where steam-engines were used underground, it was necessary to provide some means of destroying the steam. So long ago as 1864 he had adapted a cistern for this purpose. The exhaust-steam from the engine entered the cistern, having a perforated cover, and the water delivered on the top passed through and condensed all the steam.

Mr. H. D. D. Barman (Airdrie, N.B.) said that the paper was written by himself as a mechanical engineer, and the question as to whether air, electricity, or ropes should be employed in preference to steam underground was one which must be decided by the mining engineer. The Riedler pump, however, could be driven by any of these methods. He did not quite understand Mr. Steavenson with reference to the difference between the terms "plunger" and "ram": to his own mind the terms were interchangeable. The ram he should say was the moving part that practically filled the barrel, and the plunger was one which occupied a very small space in the pump-barrel. In the first pump that he designed, he left only $\frac{1}{4}$ inch of clearance between the sides of the barrel and the plunger, and this caused considerable trouble: and his chief object now in designing a new pump was to use a small diameter of plunger or ram, in comparison with the diameter of the barrel. Some engineers tried to get all the water into the barrel and to sweep it all out at the next stroke, but this gave rise to high velocity, and high pressure where corners had to be turned, and often resulted in a burst.

At Niddrie colliery, near Portobello, the difference between the pump-diagrams and the steam-power diagrams was 9·2 per cent. Prof. John Goodman had recently read a paper* in which he shewed definitely with accurate measurements of the water pumped and the swept volume of the pumps that there was at certain speeds a very big plus-efficiency with steam-pumps: and further, he actually took out the suction-valves and delivered water without using a suction-valve. The efficiency of a series-

* *Proceedings of the Institution of Mechanical Engineers*, 1903, vol. i., page 123.

centrifugal pump was about 60 per cent., as compared with the 92 per cent. of the Riedler pump.

Mr. J. G. Weeks (Bedlington) endorsed the advice of Mr. Steavenson with regard to keeping steam out of the mine if possible, and his own experience was such that he would go to considerable expense to avoid taking steam underground. If they could derive power by means of works on the surface and convey it underground through the instrumentality of ropes, compressed air, electricity or water-pressure rather than steam it was desirable, from a financial point of view, to do so. He believed that the Riedler was an excellent pump under certain conditions, but what they required to know was the special conditions under which it could be applied to get the greatest benefit from it. He understood one of the chief advantages claimed for it was that it had mechanically controlled valves, which allowed a much higher speed to be obtained with a smaller plant, than those engines and pumps which depend upon atmospheric pressure for operating the valves. He also understood in the case of the Riedler pump that it was necessary that the plunger should be placed below the level of the water to be pumped, as if by any means, the plunger made a false stroke, owing to the water not passing quickly enough to it, then there was a great risk of considerable damage ensuing: this liability somewhat limited its general application unless a small lifting set, to pump into a cistern situated at a higher level than the plunger was also attached to the engine, and any failure to keep the cistern supplied with water would be equally disastrous.

Mr. J. C. B. Hendy (Etherley) asked whether there had been any case where the Riedler pump had been successfully employed in pumping against a head of 700 or 800 feet. With a large head of water, mechanically speaking, the principle of high-speed pumping was wrong. As the power was increased against the machine, they ought to increase the capacity of the machine and decrease the speed. He could understand a high-speed pump working successfully up to 150 or 200 feet or even more, but he could not imagine it working at a high speed against such heads of water as they had to deal with in the North of England. Had the Riedler pump been successfully employed against a head of, say, 1,500 feet, and what was the efficiency under such circumstances?

Mr. H. D. D. Barman, replied that the Riedler pump would draw 24 feet above the level of the water, but with such a high lift the velocity of the water through the suction-valves should be reduced. In some instances it is advantageous to use a separate condenser and an air-pump arranged so that all the water to be pumped is drawn by it from the sump, and then delivered into a tank, above the level of the main-pump. In one instance, the water was lifted 18 feet high through 100 feet of pipes. Fig. 9 (Plate X.)* showed that a pressure of 1 or 1½ pounds was given by the height of the water-tank and that the water ran direct to the suction-vessel. If there was likely to be shortage of water, the deficiency was given out by that contained in the suction-vessel. At Powell Duffryn colliery, there was a head of 1,660 feet, and the difference between the pump-diagrams and the steam-power diagrams was about 10 per cent. It was not necessary to alter the speed in accordance with the head of water, as the speed only varied with the length of stroke. The highest head was about 3,000 feet, and the piston-and-ram speed was about 500 feet per minute.

Mr. A. L. Steavenson said that he must not be understood to condemn the Riedler pump, but only to question the circumstances under which it was best to use it. He had long used petroleum-engines underground, in preference to steam.

The Retiring President (Sir Lindsay Wood, Bart.) understood that the Riedler pump, being reciprocating, could be driven by any particular power. He agreed with other speakers that the use of steam was very undesirable down pits, but there would be no difficulty in driving the pump by electricity or compressed air.

Mr. H. D. D. Barman said that electricity was better than steam for driving the Riedler pump, on account of the speed of the motor.

Mr. J. K. Guthrie understood that the motor could be coupled direct to the pump.

Mr. H. D. D. Barman said that was so, but most people objected to pay the price for a low-speed motor: 1 to 4, or 1 to 6, was a very desirable gear, which allowed the use of the ordinary "market" motor and the ordinary type of Riedler pump.

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* *Trans. Inst. M.E.*, 1903, vol. xxv., page 248.

DISCUSSION OF MR. T. ADAMSON'S PAPER ON "WORKING A THICK COAL-SEAM IN BENGAL, INDIA."*

Mr. F. L. G. Simpson (Mophani Mines, Central Provinces) wrote that a few errors had occurred in the printing of his remarks:—Page 398, line 1 should read "especially where cogs"; and page 399, lines 2 and following should read "Afterwards, however, it being found possible to remove them, the 'brokens' were taken out clean by a system of modified longwall, in three or four lifts one above the other, the first being taken next the thill, followed up by packing. This packing, sent down from the surface, was used to haul out the coal by a self-acting incline."†

Mr. G. E. Harris (Margherita, Upper Assam, India) wrote that for some years he had had to deal with the working of thick seams, although of much greater thicknesses and under conditions different from those described by Mr. Adamson in his paper. To any one not acquainted with thick-coal working, the method described would no doubt appear dangerous, but the fact that accidents are very rare, and that such a large percentage of coal is got from the seam speaks well for the success of the system adopted. The general conditions lend themselves to this successful system of working, the main factor being the particularly fine roof immediately over the coal-seam—a very strong indurated stone. The coal is hard and compact, the inclination slight, and fires are seldom, if ever, known to occur. The immunity from fires allows large openings to be made, which facilitate the working of the coal. If fires were of frequent occurrence, smaller openings with thick fire-ribs would have to be left, and this would considerably reduce the percentage of coal obtained.

A few years ago, he (Mr. Harris) visited the Bengal coalfield, and had an opportunity of seeing the system then generally in vogue. What struck him most was the very large size that the roadways were made in driving out, and the very small

* *Trans. Inst. M.E.*, 1903, vol. xxv., pages 10, 192 and 396.

† *Ibid.*, 1903, vol. xxv.

pillars that were left. This no doubt enabled a very big percentage of the seam to be extracted in the first drivings, but he was curious to learn what the result would be when the time came to work back the pillars. He believed that on several occasions the result had proved disastrous and large areas of coal were lost owing to the pillars being crushed, due no doubt to their very small size.

He (Mr. Harris) noticed that the roads are driven with an area of about 48 square feet, and that the pillars are left about 80 feet by 120 feet. This seemed to him the proper thing to do, so as to ensure the getting of the pillars in the future working. He should like to know whether Mr. Adamson had found that these pillars were of sufficient size to withstand the crush. He did not see how "wind-blast" could be avoided with such large areas, but accidents from this cause were reduced to a minimum by the precautions taken.

The working of a seam in Fifeshire had been referred to by Mr. J. B. Atkinson, of a similar thickness to the one described by Mr. Adamson, but that seam had about 3 feet of inferior coal, at the top and bottom, which was not worked. This reduced the seam to a thickness of about 12 feet, and he understood that it was successfully worked by the longwall system in two "carries." This, however, was very different from working a seam 21 feet thick, and he did not think that the longwall method could be successfully applied to seams approaching so great a thickness.

Mr. Thomas Adamson (Giridih, India) wrote that page 397, line 4 should read "the 15 feet of top coal."*

The fallen coal referred to by Mr. F. L. G. Simpson† is loaded out, by commencing from the bolt-holes and working towards the goaf. No one is allowed to work on the goaf-side of a fall of coal. When the coal has been cleared away from the bolt-holes and sufficient room has been made a cog (chock) of hardwood timber (10 inches by 5 inches by 5 feet) is built from the floor to the main roof. Cogs are built systematically, at intervals of 15 feet, whether the condition of the roof requires them or not. Props, 21 feet long and

* *Trans Inst. M.E.*, 1903, vol. xxv.

† *Ibid.*, 1903, vol. xxv., page 397.

6 to 8 inches in diameter, are also set between them, 5 feet apart, as the coal is being loaded out. It usually takes from 3 to 6 days to load out a fall of coal. The coal, after being dropped, is fenced off for 8 hours. It has been found by experience that *chowkidars*, 10 feet square, are large enough for the purpose of indicating when the roof commences to weight, and allow time for removing the workpeople to a place of safety. When the knobs show signs of crushing, they are not reduced any more, the timber is immediately drawn, and the coal dropped. The dimensions of the pillars enable them to withstand any crush.

The removal of large areas of coal has caused subsidence of the surface, which admits water into the mines; and this is drained by the pumping plant. A rainfall of 6 inches in as many hours (as stated by Mr Simpson) is not common in the Kurhurbaree coal-field. The average rainfall for the year—which practically all falls between June 15th and October 15th—is about 50 inches.

DISCUSSION OF MR. É. GOSSERIES' PAPER ON "THE GUIBAL FAN COMPARED WITH A DYNAMO."*

Mr. Gustave Hanarte (Mons, Belgium) wrote that a dynamo and a Guibal fan or a fan of any other system are not only dissimilar machines, but they possess entirely different properties.

When an exhausting or a forcing fan is put into movement by means of a motor on a passage, on a network of passages, or on a mine, for instance, the air, which is put into motion owing to the revolution of the wings, goes into the mine at atmospheric pressure and, after having traversed the length of the galleries, it reaches the fan with a loss of pressure or water-guage, H_m, which can be calculated as follows:—$H_m = KLPV^2/S$. P being the average perimeter of the galleries of the mine, V the velocity of the air per second, and S the average section of the galleries. V being equal to Q/S, the formula becomes: $H_m = KLPQ^2/S^3$.

* *Trans. Inst. M.E.*, 1901, vol. xxi., page 568; and 1903, vol. xxv., pages 44 and 211.

This expression of the loss of pressure is the same as that which is used in hydraulics and for incompressible fluids; it is only approximate in the case of air and gases, because the volume occupied by a gas is inversely proportional to the pressure under which it exists, in accordance with the law known as that of Boyle or Mariotte. For example, a volume, Q, of 100,000 cubic feet of atmospheric air at a pressure of 33·90 feet of water may be assumed to traverse a mine by means of a fan and to reach the fan-inlet depressed by a quantity, H_m, equal to 0·66 foot of water. By the law, we write that 33·24 feet : 33·90 feet = 100,000 : x. Consequently, x equals 101,985 cubic feet; and the volume of the atmospheric air entering the mine has consequently increased by 1,985 cubic feet.

In order that the formula may be more correct, Q should represent the mean volume or (100,000 + 101,985 ÷ 2) 100,992 cubic feet.

To expel, into the atmosphere, the volume, Q, expanded at the water-guage, H_m, in the mine, it will be necessary to recompress this volume of air by means of the fan, that is to say, to reduce the volume by a quantity equal to 1,985 cubic feet. This work of recompression of the fluid and of expelling it into the atmosphere is expressed practically but erroneously by QH_m, which is the formula of the compression of liquids.

If it be assumed that the exhausted volume, Q, is proportional to the number of revolutions, N, of the fan, the value of H_m may also be expressed by the expression: $H_m = KLPN^2S^3$.

Consequently, the potential which the fan must give to the air in order to expel it into the atmosphere is proportional to the square of the volume, Q, or to the square of the number of revolutions, N: and at all speeds, when the fan is exhausting air from the mine, the expression $Q\sqrt{H_m}$ or $N\sqrt{H_m}$ will remain constant, as it will be possible to check on the manometer or water-gauge, if, of course, the orifice of the tube in the drift be placed suitably.

Let us now see what is the law which regulates the rotation of a dynamo. If a dynamo having a number of spirals, n, makes N revolutions per minute, the voltage or electromotive force, E, will increase according to the law: $E = n N \Phi$, Φ being the magnetic flux.

In the case of the dynamo, the potential will not conse-

quently increase according to the same law as in the case of the fan, and its increase will only depend upon the number of revolutions.

If, for example, the air reached, with 1 inch of water-gauge, the inlet of a fan making 100 revolutions, it will attain 9 inches of water-gauge when the fan is turning at a speed of 300 revolutions, and the air will have to undergo a corresponding recompression 9 times greater; whereas, if at a speed of 100 revolutions the electromotive force given by the dynamo is 10 volts, it will only become 30 volts at a speed of 300 revolutions, that is to say, 3 times greater.

In the case of a fan, the values are always constant:—

$\frac{100 \text{ revolutions}}{\sqrt{1}} = \frac{300}{\sqrt{9}} = \frac{N}{\sqrt{H_m}} = \frac{Q}{\sqrt{H_m}}$; and in the case of the dynamo, the constant values are:—$\frac{100}{10} = \frac{300}{30} = \frac{N}{E}$.

There is consequently a complete and essential dissimilitude between the working results given by a fan or a dynamo.

But there is something very strange, as in order to establish a certain similitude between these two machines, Mr. Gosseries places on each machine an adjunct, which, as it will be seen later, gives a bad result. In the case of the fan, he adds at the inlet a tube, *t*, which draws in air from the external atmosphere, the flow being regulated by a tap, *r* (Fig. 1, Plate I.). He adds to the dynamo on the collectors or brushes, the parts which conduct the electricity, (Fig. 2, Plate I.) a shunt.

Let us now examine, first, what influence the addition of a tube taking the external air and conveying it to the inlet will exert on the ventilation. Therefore, for the moment it will be supposed that the tap, *r*, of the tube is entirely closed; the fan will then only receive air which has traversed the mine, and the equation of the indicated work, T_I, determined from indicator-diagrams taken on the steam-engine, will be:—

$$T_I = T_{Rm} + T_{Rv} + QH_m + Qh_v \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

T_{Rm} being the work which has been absorbed by the adverse metallic resistances of the motor, T_{Rv} the work absorbed by the metallic resistances of the fan due to its weight and the dimensions of the rubbing axle; QH_m the work absorbed by the friction of the air in the mine producing the depression or

loss of pressure, H_m: and Qh_v, the work absorbed by the friction of the air in the fan producing the loss of pressure (subsequent to the other) h_v. Only one of all these absorbed works is useful in the ventilation, that is QH_m, by means of which the air circulates in the mine and which determines the efficiency, R, determined by the formula: $R = QH_m/T_1$.

All the other factors of the second member of the equation, lessen the efficiency, R.

The depression, H_m, to which the atmospheric air that has traversed the mine is subject can be checked on the manometer or water-guage, D, put into the inlet of the fan and having the mouth, A, of its orifice bent at an angle of 90 degrees, provided also with a bevelled collar, K, and placed in a plane parallel to the direction of the air-current (Fig. 3, Plate I.).

The air, expelled by the blades through the fan, is still subject to a depression of a new quantity, h_v, owing to the friction against the sides of the machine. It is very difficult, however, to measure this depression, h_v, as the orifice of the tube of the water-gauge should be placed immediately at the place where the air passes away from the blades of the fan.

The characteristic of the exhausting fan consists in recompressing and expelling the volume, Q, into the atmosphere, together with the quantity, $H_m + h_v$, by which the pressure has decreased owing to the friction of the mine and of the fan. Fig. 4 (Plate I.) is a sketch representing exhausting ventilation. The air enters the mine at A, at atmospheric pressure, p, reaches the inlet of the fan, B, expands by a quantity, H_m, leaves the blades at C, at a new pressure, h_v, and is expelled at D into the atmosphere through the chimney of the fan according to the curve of recompression, CD, which forces it out at atmospheric pressure.

Instead of the formula, QH_m, used for greater facility of calculation, the exact formula of the useful work of the extraction of the air and of its expulsion into the atmosphere ought to be written, if the recompression be taken into account: $-pQ$ (log. nap. of $p'p - H_m$), P being the absolute pressure of the atmospheric air.

If the depressions which are to be surmounted were too great, as it is in the case of the extraction of the air out of the

nets of rarefied air, very important errors would evidently result by using the formula QH_m.*

Fig. 5 (Plate I.) is a sketch of forcing ventilation. The air enters the fan at B, and there it expands, by h_r, in traversing the fan, and is recompressed on account of its impulsion not only by the same quantity but also by a quantity H_m, which is used in overcoming the resistances of the mine, commencing from D; finally the air leaves the mine, at A, at atmospheric pressure. Generally, the work of the forcing fan consists in compressing the air by $h_r + H_m$, the same as in the exhausting fan.

Supposing now that the fan turns at the same speed, that the tap, r, is opened and air comes to the inlet of the fan through the tube, t, and through the mine, m (Fig. 1, Plate I.), the indicated power, T_i, will be constant; and this has been proved in the case of a fan working on resistances or mines of different temperaments. In experiments made on orifices of different areas, the indicator-diagrams taken on the steam-engine are superposed exactly on each other. The resistant powers, T_{Rv}, and T_{Rm}, will also be constant.

If h_t be the depression occasioned by friction in the tube, t, in a volume, q, arriving from the atmosphere at the inlet of the fan, without any profit, however, for the ventilation of the mine, the work of recompression that the fan has to supply in order to expel this new volume which is uselessly produced will be qh_t.

It will be then possible to lay down according to equation (1), the identical terms being eliminated, that:—

$$QH_m + QH_v = Q H_m + (Q' + q)h_r + qh_t \quad . \quad . \quad . \quad (2)$$

Q' being the new volume traversing the mine.

But if, for facilitating the demonstration, $\pm$, the tap, r, be opened in such a manner as to have the volumes $Q' + q$ equal to the volume, Q, which originally traversed the mine, the volume which will traverse the fan will be equal to Q, and the work which the fan will absorb on account of friction will be still Qh_r; $Q/\sqrt{h_v}$ being constant. It may then be laid down according to equation (2), that:—

* *Prolégomènes à l'Étude Rationnelle de la Ventilation: L'Air Raréfié: Théorie et Calculs faits pour sa Production, sa Transmission et son Utilisation: Résultats comparatifs de son Emploi et de celui de l'Air Comprimé pour la Transmission de la Force à Distance*, by Mr. G. Hanarte, 1886.

$QH_m = Q\,H_m + qh_t$; whence QH_m' is greater than $Q\,H'_m$.

The useful work will be therefore reduced and the efficiency will be:—$Q'H'_m T_I$ equals R', whence R' is less than R. This decrease of the efficiency will increase as qh_t becomes greater, so that:—

$$\frac{Q}{\sqrt{H_m}} = \frac{Q}{\sqrt{H_m}}; \text{ and } \frac{Q}{\sqrt{h_v}} = \frac{Q + q}{\sqrt{h_v}}.$$

He (Mr. Hanarte) thought that Mr. Gosseries made a great mistake in thinking that he could help the ventilation by creating a high water-gauge, h_t, in the tube, and this result he obtains by reducing the orifice of the tap, r. This mistake must be assigned to the fact that he considers the fan, and not the friction of the mine, as being the direct cause of the water-gauge, H_m. He confuses the static rarefaction and the ventilating rarefaction due to the air in movement, which engenders H_m. By thoroughly considering that any fan, whether exhausting or forcing, is a compressor of the air, which expands on account of the friction of the mine, it is impossible to make such a mistake.

In equation (1), the terms T_{Rv} and Qh_v characterize the fan. It is possible to evolve these characteristic terms:—(1) By forcing the machine to turn empty: the indicator-diagram, then taken, indicates the value of T_{Rm}: and (2) by determining carefully QH_m. In this operation, Q must be measured at the top of the chimney, the air having there taken up again its atmospheric density, and H_m must be determined by means of the end of the tube of the water-guage placed in the air-current as previously described. Indeed in the equation:—$T_{Rv} + Qh_v = T_I - (T_{Rm} + QH_m)$, T_{Rv} depends upon the weight of the machine and of the rubbing surfaces, and Qh_v upon the dimensions of the passages of the fan relatively to the volume, Q, which has to traverse it. The larger the volume, Q, the larger also must be the fan, all conditions being unchanged, the greater will become the quotient $Q\sqrt{h_v}$, the smaller will become T_{Rv}, and the higher will be the efficiency of the fan and the useful work, QH_m.

Let us observe now the mode of working of a dynamo. In principle the magneto machine, in question, will have, for a constant number of revolutions, a constant difference of potential at the poles for a determined yield. Indeed, the electromotive

force equals $n\mathrm{N}\Phi$: n, being the number of spirals around the inductor; N, the number of revolutions per minute, and Φ, the magnetic flux. These three factors being constant, the electromotive force is, of course, constant.

If such a dynamo be supposed turning on an external determined circuit of a resistance R, the whole electromotive force of the dynamo will be, say, E; and the electromotive force at the poles will be e less than E for a yield of I ampères. The equation of the indicated power is:—

$$\mathrm{T_I} = \mathrm{T}_{Rm} + e\mathrm{I} + (\mathrm{E} - e)\mathrm{I};$$

T_{Rm} being the work absorbed in mechanical resistances; $e\mathrm{I}$ the useful work in watts; $(\mathrm{E}-e)\mathrm{I}$, the work absorbed in watts by the dynamo, that is to say, the ohmic resistances and the reactions of the inductor.

For the calculation of T_{Rm}, you furnish by means of an external spring, an electric current in order to cause the dynamo to turn as a motor at the speed at which the machine has to turn as a generator; the mechanical resistances, T_{Rm}, will then be measured in watts. We may then lay down the characteristic of the dynamo for a yield or useful work equal to $e\mathrm{I}/\mathrm{T_I}$. Supposing the inductor turning between the poles of the magnet produces a difference of potential, E, at the speed N; the circuit of lamps, l, l, l, l, of resistance, R, (Fig. 2, Plate I.) closed, and the useful voltage being e, at the collectors, the electric current will be:—$\mathrm{I} = e/\mathrm{R}$. If otherwise, we put on the collectors a resistance, r, in derivation, the combined resistances of the two circuits, R and r, will be (according to the derived currents) $\mathrm{R}r/(\mathrm{R} + r)$ and will be less than R. Consequently, the current which will be generated by the machine will be greater than before the derivation, taken for instance equal to J; and it will always be so, whatever the value given to the shunt or derivation may be. But, the magnet being fixed and the number of revolutions constant, the difference of potential produced, which we call e' will be less than e, and the useful yield for the indicated work will be less than before.

Indeed, $e'\mathrm{J}/\mathrm{T'_I}$ will be less than $e\mathrm{I}/\mathrm{T_I}$, e' being less than e; the ohmic resistances and the reactions of the inductor having increased according to J/I.

It has been seen from this analysis that the comparison

between the fan and the magneto dynamo is not a logical one, as previously remarked. The sole similarity that these two machines may have is due to the fact that they both revolve. The fan turning at a constant number of revolutions being able to give a fixed work, the addition of a tube causing useless work diminishes of course the useful volume, Q, which traverses the mine: and this decrease, multiplied by itself, gives the measurement of the decrease of the loss of pressure, H_m.

On the contrary, the consequence of adding a shunt to the dynamo has been to increase the yield in ampères and to have occasioned a fall of the potential proportional to the additional yield, the ohmic resistances and the reactions of the inductor having increased.

It is also very difficult to understand how it should be possible to maintain the constant potential of the machine by modifying the resistances of the shunt: in fact, the machine with independent excitation can be assimilated to the pile at constant speed and of variable yield, the curve of the potentials falling as shown in Fig. 6 (Plate I.). But any shunt put on the poles of the dynamo, whatever its resistance may be, diminishes the resistance of the external circuit according to the derived circuits, as has already been mentioned; thus the current increases, and there is consequently a decrease of potential.

The comparison between the fan and the dynamo can be set forth as follows:—

Fan.—(1) The water-gauge of the air corresponding to the compression, which the air has to undergo in the fan, is proportional to the square of the speed.

(2) The water-gauge is proportional to the square of the yield, or of the number of revolutions.

(3) The regulation is possible by means of the tube, in such a manner, if the same volume passes through the fan.

Dynamo.—(1) The electromotive force is proportional to the speed of the dynamo.

(2) The loss of pressure or electromotive force is proportional to the yield given by the dynamo.

(3) The regulation by means of the shunt, in order to have the same yield of the dynamo, is impossible.

To illustrate Mr G. Hanarte's Paper on "The Guibal Fan compared with a Dynamo."

FIG. 4.—SKETCH OF EXHAUSTING VENTILATION.

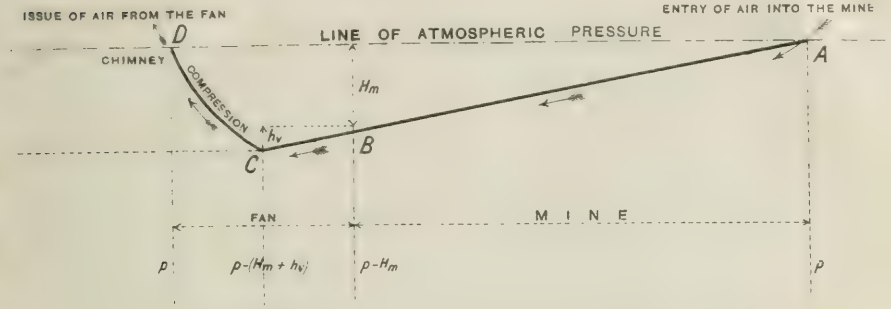
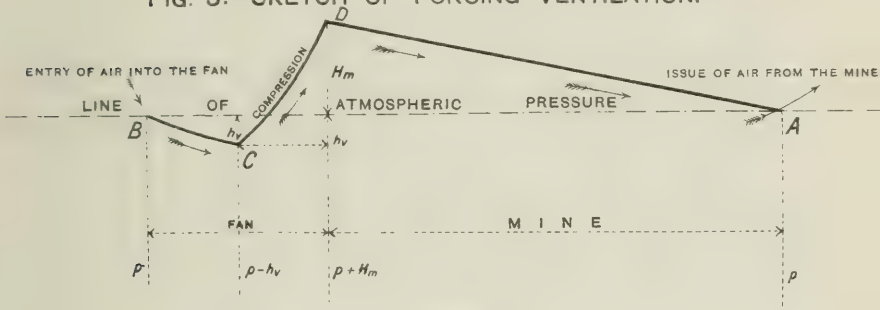


FIG. 5.—SKETCH OF FORCING VENTILATION.



REFERENCE.

The Arrows Indicate the Direction taken by the Air; and, the Vertical Lines, the Absolute Pressures of the Air.

FIG. 1.

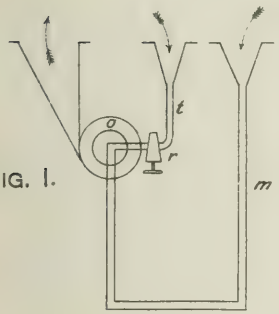


FIG. 2.

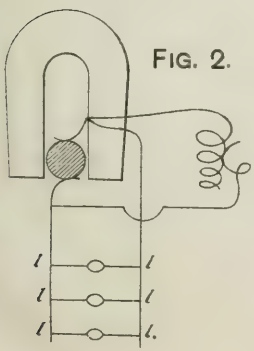


FIG. 3

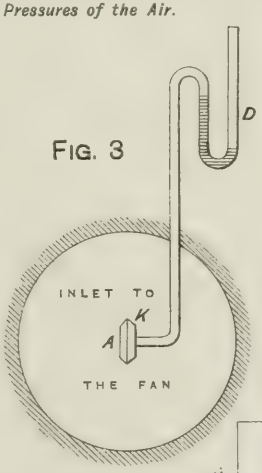
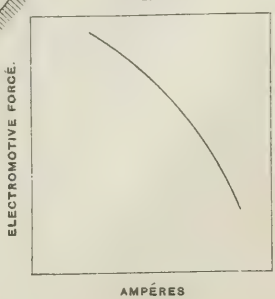


FIG. 6.



DISCUSSION OF MR. S. J. POLLITZER'S PAPER ON "THE UNDERLAY-TABLE."*

Mr. S. J. Pollitzer (Sydney, New South Wales), in answer to the various criticisms, wrote that Messrs. A. Lupton and J. Henderson recommend each a different instrument instead of the inventor's table; the first-named of these two gentlemen favours the Hedley dial, and the second the Henderson rapid traverser.† The writer had used the Hedley dial with success; but he did not remember having seen the Henderson traverser, which he supposed was in principle the same, though with considerable improvments. He (Mr. Pollitzer) was, however, of opinion, fortified by his experience, that neither of these instruments were suitable for such a shaft as the three described in his paper; and the writer distinctly stated in his paper that if an underlay shaft be of uniform grade right through from top to bottom, he would not suggest the use of his table.‡ Again, Mr. B. H. Brough, stated that it could be replaced by the recently invented theodolite of Mr. Dunbar D. Scott; now, with the greatest regard for that American gentleman's invention, the writer was compelled to confess that even this finest of mining instruments would not be in its proper sphere in such a shaft.§

And really it is of no use to make statements on one side and counter-statements on the other; among men of intelligence the proper course is to argue a point to the finish, and see on which side there is logic supported by facts. The primary reason that optical instruments are not adaptable for this work is that they have much too short legs; that they cannot be fixed in the surrounding country-rock like the underlay-table, but must be placed on a specially prepared platform, which can never be made rigid enough to avoid vibration; and, even if the legs were long enough, the observer must have a safe and pretty large platform to be able to use the telescope in all directions, which in nearly all cases will find itself in about fairly the middle of the shaft. The erection, therefore, of such a platform at every change of grade is an objectionable and heavy piece of work, causes vibration, and will make the results of the survey not absolutely but only problematically correct. With the writer's

* *Trans. Inst. M.E.*, 1903, vol. xxv., pages 24 and 196.

† *Ibid.*, pages 33 and 196. ‡ *Ibid.*, page 25. § *Ibid.*, page 35

underlay-table all this labour is avoided, as no platform is required: one single stout board is nailed near the very footwall about 1 foot below the level of the underlay-table upon which the surveyor is safely sitting, and he can quite comfortably handle it. His assistants hardly ever want even a board, because the shaft-timbering will afford plenty of safe seats from which to manipulate the plumb-lines. The second objection is the awkwardness of tying in the telescope into the back-sight and revolving it for the front-sight, necessitating too much walking about a sensitive and delicate instrument in a cramped and dangerous position: and lastly the centreing of the instrument and ascertaining its axial height over the point which the writer questions can be done with precision. With the underlay-table all this is avoided. His critics ought to bear in mind one all-important fact, that even the smallest error made in reading an angle with a theodolite multiplies itself as the distance increases, but on the contrary—even assuming that the most trustworthy underlay-table assstant makes an error in marking the plumb-lines—such an error can at best only remain constant, and is not increasing.

Mr. B. H. Brough further remarks that the underlay-table is too costly: this contention is quite correct and applicable to the price given by the author, who ought also to have stated that much of the price he had to pay for it was due to discarding several parts and having them replaced by others. The price of the two telescopic tubes, for instance, was simply exorbitant, and yet the maker had hardly any profit on it, because such tubes had to be cast to order, as at that time none were to be had ready-made in Australia. Taking further into consideration the higher Australian rate of pay, the writer was of opinion that such a table made anywhere in Europe should not cost the half of what he had to pay for it.

Mr. J. Henderson said that a shaft, under an angle of 60 degrees and 100 feet long, will require a shifting of the table 25 times. The writer cannot assume that Mr. Henderson should have made so palpable an error in this most simple of calculations, which, at times, we are all apt to commit. But he (Mr. Pollitzer) accuses his critics of committing a most unpardonably gross breach of fairness and equity by criticizing without having properly read or correctly understood his paper. For

had Mr. Henderson done so, he would have seen in that paper an example quoted where the offset, which means the cosine of the underlay, is 5 feet 4½ inches, and can be got larger still. Therefore, there would be only nine or at the outside ten shiftings of the underlay-table, and not 25 as Mr. Henderson stated. Nor is Mr. Henderson right in all his other calculations, and the only angle suitable for one fixing is not at 88 degrees 51 minutes as he states, but it occurs at an angle of about 87 degrees 10 minutes.

Mr. A. Lupton states that the shaft should be at one's disposal for a considerable time. In the survey described by the author that was the case: however, there was absolutely no interruption in the usual working of the mine, and moreover it was an imposed condition that no interruption would be allowed. At that mine, the workings were carried on during two shifts only, and the night-shift, that is from 11 p.m. to 7 a.m. on the following morning, was the time allotted for surveying. Taking further into consideration that having to disengage the cage at night-time and re-engage it again in the morning (both operations wanting about an hour's time) the writer had barely seven hours at his disposal to carry out his tedious underlay-table operation. The average daily progress was at the rate of about 90 feet of depth per shift, proving that it was certainly a very slow process. Every plumb-bob point was permanently marked in the shoot by a nail, and was easily found at the next shift or, for that matter, many days later, so that there was no chance of loosing a connection or an impossibility of checking the work.

The writer confesses to having made a most grievous error in his illustration of the 12 miles base-line to the earth's quadrant being in a proportion of 1 to 8,300; for this is utterly wrong, and the proportion is barely like 1 in 500. The writer is at a loss to say how this error occurred, he is extremely sorry for it, and he hopes that the members will regard it as a clerical error.

Finally, the writer wishes to say that although his contribution was of the most modest kind, he feels an excusable satisfaction in having contributed his modest mite towards the advancement of the mining industry in general, and in particular towards that of sunny Australia, the fair country of his adoption.

DISCUSSION OF MR. S. J. POLLITZER'S PAPER ON "A MEASURING-TAPE, AND ITS USE IN MINE-SURVEYING."*

Mr. S. J. Pollitzer (Sydney, New South Wales), in answer to various criticisms, wrote that he could not boast of an experience of 20 years in underground surveying like Mr. H. Jepson, but he (Mr. Pollitzer) had enough experience with the theodolite in this kind of work to refute Mr. Jepson's positive assertion on the one hand, and on the other to assure him that this tape is the very outcome of his (the writer's) experience; and moreover Mr. Jepson admits that under the circumstances it is the most convenient instrument. And no doubt it is so, says the writer.

The writer is afraid that there is something of the disbelieving Thomas in his critics because he (Mr. Pollitzer) many months afterwards was informed of the success of his survey, as stated in his paper; and yet Mr. Jepson asserts that it is not possible to make as accurate a survey with it as by an optical instrument.

Mr. Jepson makes another assertion by saying that the wire "is free to move, as it ought to be, and it did move." To this it must be answered, "it did not move"; and to be sure of that, all the necessary precautions had to be taken, otherwise one would not be able to say whether it did move or not; because in such a very fine and thin wire one cannot possibly detect any slight movements with the naked eye in open daylight, far less in a dark mine lit up with a few candles. The two shafts were well ventilated, however, without any strong air-current: one of them was dry and the other was in fact so wet that the manager, at one time, grudged the excessive loss of oil in the bucket. Yet the writer could never discover an unsteadiness in the wire caused through the dropping water. Whenever the wire did happen to move, the cause invariably was accidental, say somebody would happen to knock against it, or a piece of some falling hard substance would come against it; but with the plummet in the oil, it did not take more than 2 minutes to be steady again as before. The period required to do it, is not too protracted: and one shaft, with 8 or 9 levels, can be surveyed or connected in one day of

* *Trans. Inst. M.E.*, 1903, vol. xxv., pages 17 and 205.

say 16 to 18 hours' duration, provided that all the necessary preparations have been made beforehand, and for this reason Sundays should be used when other days are not available.

The author wishes to add a material detail, which he omitted in his paper: and that is the means provided against swinging while the plummet is being slowly lowered. The wire is apt to become jammed on its wheel, and when that occurs in lowering, the wire must be forced by hand, and a swinging will be caused which may perhaps break the wire. To avoid so serious an accident to the wire, it is also carried over a small wheel, about 6 inches in diameter, from which the wire with its plummet is directly suspended. This small wheel rests on a sort of small cantilever fixed permanently to the sides of the trestle carrying the large wheel and the wire; and the small wheel is fixed on the cantilever at such a height that the common tangent to both wheels may be fairly horizontal; this tangent is represented by the wire going from the large to the small wheel, and it has a length of about 18 inches. If the wire becomes jammed on the large wheel, this tangential piece is used for forcing the wire, and the swinging of the plummet will thereby be avoided entirely.

Mr. W. M. Brewer's paper on "The Rock-slide at Frank, Alberta Territory, Canada," was read as follows: —

THE ROCK-SLIDE AT FRANK, ALBERTA TERRITORY, CANADA.

By W. M. BREWER, Victoria, British Columbia.

On the morning of April 29th, 1903, the outside world was startled by telegraphic reports that the top of Turtle Mountain in the extreme eastern portion of the Crows Nest coal-field, had been removed by volcanic eruption, that the town of Frank, a coal-mining camp situated at its base, had been destroyed, and that about 100 lives had been lost.

Fig. 1. View of Turtle Mountain, after the Rock-slide.

That any eruption should have taken place in that particular region was beyond the belief of all geologists who had studied the formations; and engineers, who were familiar with the country, expressed disbelief as to the cause postulated in the newspaper dispatches for the terrible disaster which had visited the camp. When an investigation had been made later by com-

petent engineers it was found that we were correct, and, that instead of the phenomenon being volcanic it was really attributable to an enormous rock-slide which had precipitated from 60,000,000 to 80,000,000 tons of rock (as estimated by Mr. McConnell of the Dominion Geological Survey) on to that portion of the camp which was occupied by the miners' cottages, and entirely buried six of them.

Thorough investigation proved that the disaster had been so terrible that no less than 62 persons were killed, several severely injured, that the surface-plant at the Canadian-American Coal and Coke Company's mines was totally destroyed, as well as the cottages mentioned, and the rock which fell from the mountain covered nearly 2 square miles (Fig. 1.).

Fig. 2.—View of Boulder, weighing 15,000 Tons, moved 2 Miles by the Rock slide.

The 17 miners who were at work in the mine were entombed for about 12 hours, but succeeded in digging their own way out, for apart from the main entrance being blocked, the interior of the mine was but little affected.

The following is the story of Mr. Daniel M. McKenzie, one of the entombed miners, in his own language:—

Three other miners and myself were working in a crosscut off from No. 8 manway, when we were first aware that something unusual had happened. I was leaning against a chute just at the moment; suddenly there seemed to be a falling in of the hanging-wall, and I was imprisoned between a chute-board and the coal. The coal fell from the roof in large quantities, and I was badly squeezed. My companions helped me out; and believing that something had happened, but not knowing what it was, we started to make our way to the main entry. Reaching the entry, we started for the mouth of the tunnel.

On the way we encountered the other men on shift at the time. They were running toward the mouth of the entry. On reaching that point, we found our way blocked, as the entry was completely covered over. We turned to retrace our steps. The coal was falling from the roof, and progress was difficult. We waited for an hour, debating what should be done, and finally came to the conclusion that we ought to try to get out by way of No. 8 manway, which would lead us to an air-course, which we hoped would reach the surface. I found, however, that gas was accumulating when we reached the manway, and knew escape by that route was impossible. We, therefore, returned and attempted the lower entry. That we found to be rapidly filling with water. Sticking my knife into one of the timbers to enable me to judge as to the rapidity of the rise, we went back to the main entry. Some of the men were greatly excited, and talked in the irrational way that men will in such cases, but others with myself calmed them by telling them there was no danger. It was an occasion when a lie was justifiable, for had they been allowed to realize the danger they were in, there is no telling what might have happened.

After a time, I went down to the lower entry again to see how the water was rising. I found it quite alarming, and figured that, at the rate it was coming up, we might expect it to flood the mine to the day at about 4 p.m. As we had nothing to eat but the 5 horses being worked in the mine, which were still alive, I proposed killing one of them when we should need food, and in the meantime we should endeavour to dig our way out. We selected a place near the mouth of the main entry and started to work. We timbered as best we could as we went toward the surface. We had worked, changing hands, for something more than 5 hours, when I went in personally to do my turn. I was punching with a bar, when suddenly it went through, and a breath of air greeted me. I gave a few more punches, and a rock, big enough to have killed us all, fell in. I ducked back to save myself, and looking up saw that we had reached the surface. I called back to the others, and they literally went mad with delight. We were not long in getting to the outside.

Turtle Mountain reached an altitude of about 3,500 feet above the valley of the Old-man river, but to-day the summit is only about 2,500 feet above the valley. The slide is estimated to have carried away not only the original summit of the central peak of the mountain, but also a considerable mass of the mountain-side, as it spread out in fan-shape as the material slid down the slope. The wide portion of the fan reached a width of about 4,000 feet, and the débris covered an area of 2 square miles of the Old-man river valley.

Turtle Mountain is situated near the eastern boundary of the coal-field locally known as the Crows Nest Pass, and in the eastern foot-hills of the Rocky Mountains. The greater portion of this coal-field is on the western slope of the Rocky Mountains, where it covers a very large area. The portions situated on the eastern slope, so far as at present known, are not so extensive, nor are the number of seams so great as on the western side.

The Old-man or Crows Nest River has its source in Crows Nest Lake, at an altitude of 4,250 feet above sea-level. The middle fork of the river flows in a magnetic easterly direction, cross-cutting the formation through the mountains to the gap, about 14 miles from the lake. This gap is a defile excavated by erosion and the channel of the river through a high limestone-ridge. On the eastern side of the gap is situated the coal-mining camp of Frank, at the base of Turtle Mountain.

According to the late Dr. G. M. Dawson, Director of the Dominion Geological Survey, the Frank coal-field is a portion of the Crows Nest coal-field, and the most easterly productive portion so far as at present developed. At Crows Nest Lake, the Cretaceous rocks have been removed by erosion and the Carboniferous Limestone, on which the Cretaceous rocks were laid down, is exposed. To the eastward and beyond Turtle Mountain, the structure of the Cretaceous strata is that of an anticlinal, with the mountain peaks, composed of Carboniferous Limestone, towering above the Cretaceous rocks, which originally overlaid the limestone. The dip of the strata west of the Carboniferous Limestone range in which the gap is situated is to the west, at angles varying from 45 to 60 degrees, but eastward from the gap the strata dip toward the east at an almost vertical angle.

The coal-seam mined at Frank averages about 10 feet in thickness, and lies between the Cretaceous sandstones which form the eastern portion of the base of Turtle Mountain. The main workings in the coal-mine are tunnels driven parallel to the anticlinal axis, the lowest level being about 50 feet above the valley of the middle fork of the Old-man or Crows Nest River. From that level, mining operations have been extended upwards by stoping in a manner similar to the method in vogue in metalliferous mines. As the product of the mines has for the past two or three years averaged about

200 tons per day, it will be readily seen that considerable excavations have been made, with the result that that portion of the mountain has been honeycombed with tunnels, upraises and stopes. The main level is reported as having been driven for nearly 5,000 feet parallel to the stratification of the rocks.

This feature is referred to by the writer, because it seems probable that such extensive workings near the base of Turtle Mountain would have a tendency to weaken the power of resistance of the rocks and aid the weathering agencies resulting from heavy snowfalls, extreme frosts, and rainfalls which are continuously exerting their influence upon the limestone, and chiefly at the summit.

The face of Turtle Mountain which overlooks the town of Frank was, previous to the slide, very precipitous and presented a threatening appearance; but no one who saw it, as the writer did nearly three years ago, would have predicted that there was any danger of such an extensive slide as that which actually occurred.

The dimensions of the peak that broke away are about 2,000 feet across the face at the longest point, about 2,000 feet the greatest vertical height, and a maximum thickness of 1,000 feet.

Dr. Eugene Haanel (Superintendent of Mines, Ottawa) wrote that the summary of the official report on the recent disastrous rock-slide at Frank, Alberta, was as follows:—

Summary. The base of Turtle Mountain consists of beds of shales and sandstones of Cretaceous age, and the upper precipitous portion of beds of Carboniferous Limestone. The line of separation between the two series is the plane of a thrust-fault, along which the lower limestone-beds are highly contorted and shattered. In addition to dangerously steep slopes, the shattering due to faulting and the easy separation of rock-slabs along bedding-planes, Turtle Mountain is further weakened by several series of joint-planes, which traverse it in various directions.

The Rock-avalanche. At dawn, on the 29th of April, a great slice of the mountain, ½ mile long, over 2,000 feet in height and of great thickness, including the main central peak over 3,000 feet above the valley, precipitated itself with great violence into and across the valley below, overwhelming everything in its course. The debris, consisting of limestone-fragments, together with sediments ploughed up from the beds of Old Man river and Gold creek, now cover the valley to a depth of from 1 to more than 50 feet, over an area of about 2 square miles. About 70 lives and much property were destroyed. The disaster was due to a combination of causes cumulative in their effects. The chief of these was the

structure and condition of the mountain aided by exceptional atmospheric conditions, and in all probability by the weakening of the mountain as a result of mining operations.

Present Condition and Danger.—The ground between and adjoining the two remaining peaks is badly fractured. This fractured zone, surrounding the old break, is bound to fall away, but whether it falls gradually and in comparatively harmless blocks, or in large destructive masses, depends upon future conditions, which cannot be foretold. The fissures about the northern peak render the tunnel and lower portion of the town unsafe. The safety of Frank depends upon the stability of the shoulder from the northern peak. Apparently it is still secure, but the fissures some distance back from the northern peak may extend far enough north to weaken this shoulder. If these fissures show any sign of movement, the town ought at once to be evacuated. A succession of seasons with unusually heavy precipitation and rapid changes of temperature, a slight earthquake-shock, or creeping in the mine upon drawing the mined coal, may cause a jar that will dislodge this shoulder and start it on a career of destruction. Since this possibility must always overhang the town it would seem advisable to move the site a short distance up the valley beyond the reach of danger.

The Chairman (Sir Lindsay Wood, Bart.) moved a vote of thanks to Mr. Brewer for his interesting notes.

Mr. T. Douglas seconded the resolution, which was cordially approved.

Mr. J. J. Muir's paper on "An Improved Forced Method of Treatment of Low-grade Copper-ores" was read as follows: -

AN IMPROVED FORCED METHOD OF TREATMENT OF LOW-GRADE COPPER-ORES.

By J. J. MUIR.

Introduction.—In following out the writer's investigations on the treatment of low-grade copper-ores, brought under the notice of members in a recent paper,* he has now ventured to lay before them an improved method of forced extraction, which will fulfil the conditions required in treating these ore-bodies at a commercial profit.

As pointed out in his recent paper, a great bulk of this class of ore exists in various parts of Australia and Tasmania, and in no conceivable way can it be profitably dealt with by a smelting operation. After arriving at this conclusion, the writer turned his attention in an experimental way to the various methods in general use, with a view of ascertaining what percentage of copper-extraction could be obtained by them under the existing conditions, and also at what cost. In such methods as natural-leaching, salt-roast, ferrous sulphate and the principles laid down in the Hunt-Douglas process, the results at which the writer arrived fully established the claims of all of them to a good extraction under the conditions necessary for their operation.

It is, however, essential in proposing a method of treating these ores, that the commercial side of the problem should be equally as prominent and successful as the metallurgical one. It is in the satisfactory adjustment of these two opposing factors that a solution of this subject will be found, and as a consequence increased activity in the handling of these classes of ore.

After a patient review of the foregoing results and conclusions, it appeared to the writer that the lines on which investigation must be carried out in reconciling the two factors referred to, would be a careful consideration of the chemical conditions of the ores themselves.

* *Trans. Inst. M.E.*, 1902, vol. xxiii., page 517.

The chief obstacle to be overcome, is the avoidance of the necessity of transporting large quantities of chemical re-agents to isolated positions for a treatment-process of the ores. The first cost of these re-agents in addition to their excessive transport charges in most cases renders it impossible to work out a satisfactory result. In conjunction with this difficulty, it is also necessary to arrive at a high-extraction of the copper, and, moreover, to show a speed in the work that will compare with that obtained in a smelting operation. The lines of investigation followed by the writer were therefore narrowed down considerably, and the issue on which a successful result would be arrived at clearly defined.

In considering the ores to be treated, the writer will confine himself to those typical of the West Coast of Tasmania, as these ores through their high silica-contents have baffled the smelter from the financial point of view. The writer does not suggest that these ores cannot be smelted, but that the operation results in a loss, when importing the necessary fluxes and fuels. The following is a typical analysis of these ores: Silica, 48·00; copper, 4·56; iron, 13·29; sulphur, 12·60; alumina, 12·90; zinc, 1·17; manganese, 1·26; lead, 1·40; magnesia, 3·40; and oxygen and loss by ignition, 1·42 per cent.

It will be seen from the conditions, that these ores contain a large amount of sulphur, and, moreover, that by a judicious selection of a small proportion of the ores, as they leave the mine, the sulphur-contents can be considerably increased. This is the main condition by means of which the writer proceeded to work out a method for their profitable treatment.

In the following description of this process, the writer asks the indulgence of members in the necessity he is under of referring to well-known chemical and physical facts.

Operations at the Mine.— In extracting the ore from the mine by any of the usual systems, the aim should be to roughly and cheaply throw out the richer sulphides; to the extent of from 10 to 12 per cent. of the bulk of the ore treated. This smaller proportion is reserved for separate treatment, and the conversion of its sulphur-contents into sulphur dioxide (SO_2) fumes, and in turn their conversion into sulphurous acid (H_2SO_3) by solution

in water. The main bulk of the ore then goes forward to the regular plant.

Preparation of the Ore (Main Bulk). The ore is first reduced to such a degree of fineness as the operator may find necessary, in order to expose the small sulphide-particles to the oxidizing flame of the reverberatory calciner. The machinery employed for this purpose can be adapted by any individual operator to suit himself. The writer would employ a Gates crusher followed by rolls, the schistose ores being soft and easily dealt with.

Calcination of the Ore.—In this connection, the writer would like to mention that the type of reverberatory calciner described by Dr. Peters in his *Modern Copper-smelting* is well adapted for this process. The stage to which the calcination must be carried is the first important consideration in dealing successfully with these ores. Provided that the last of the sulphides, as such, have been converted, it is a matter of no moment what proportion the residual oxides and sulphates bear one to the other, and the charges can be drawn at that stage. The sulphates being easily soluble, the writer provides for the attack on the oxides only.

Forced Leaching of the Ore.—The calcined ore is then transferred to the wooden leaching-vats (fitted with filter-bottoms), being discharged gradually and hot from the furnace on to the sulphurous acid (H_2SO_3) plus water-solution, derived from the ore that has been separately treated. The best mixing proportion is 200 gallons of solution to 1 ton of the roasted ore. The ore is covered, and the temperature considerably raised by the hot ore. The hot air-blast (described under the separate treatment) is then turned on, and the temperature is further raised. The copper oxides are attacked very rapidly by the sulphurous acid, following the equation $CuO + H_2SO_3 = CuSO_3 + H_2O$, and the extraction is completed in a very short time.

The hot oxygen of the blast tends to oxidize the surplus sulphurous acid (H_2SO_3) into sulphuric acid (H_2SO_4) and this is an advantage. The chilling effect of the cold solution on the hot air is greatly obviated by the initial raising of the temperature with the hot ore: and it will be found that a rapid extraction temperature is quickly reached.

Precipitating the Copper. The strong copper-solution is then run into the precipitating-vats on to bars of pig-iron, and the temperature is again raised for a quick precipitation. One wash-water will recover the soluble copper in the dampness of the ore.

Separate Treatment of the Selected Portion of the Ores.—This portion being higher in sulphur-contents than the main portion of the ore-body, will be used for making the sulphurous acid necessary for leaching the whole of the ores. It is essential that as little of the sulphur contained in these ores should go to waste as possible, and it is, therefore, necessary in the arrangement of plant to provide for this. Pyrites, heated in a closed muffle or retort, does not give up the whole of its sulphur; but this result can be minimized by admitting a light pressure of compressed air, sufficient to overcome the head, due to the depth to which the fume discharge-pipe is immersed. The hot-air coil is arranged in the furnace-chamber of the muffle, so as to utilize the heat from the same fuel and minimize cost. Both the hot-air and fume discharge-pipes are led into the leaching-vats, and the water-charge is thus prepared for the reception of the hot ore from the calciner. The pressure behind both of these pipes is, of course, regulated to suit the mechanical conditions.

By the adjustment of these conditions to the ores under treatment, and according to the detailed plant which the writer has designed, a rate and cost of production can be obtained that will successfully deal with these ores.

Cost of Treatment per Ton of Crude Ore.—Under the conditions prevailing where these ores exist, the cost of treatment would be as follows per ton of crude-ore:—

	s.	d.
Crushing schistose ores	5	0
Reverberatory roast	3	6
Labour on leaching-vats	0	6
Hot air	0	6
Sulphurous-acid water	2	6
Pig-iron	2	0
Total	14	0

In addition to this, mining and delivery of the ore to the works by self-acting tram, would cost 10s. or, say, a total of 24s. per ton of crude-ore. Against this, a deduction of 4s. could be safely made on the copper-recovery from the muffle-roasted ores, leaving everything well on the conservative side.

Under average conditions, therefore, the total charges against the ore would be £1 per ton, and the precipitated copper will range in assay-value from 70 to 80 per cent. It would be the final product of this process, and the writer feels it unnecessary to follow it further on its course to refined copper. There is a ready market for this high-grade product, so that returns and final adjustments can be made at short notice.

Conclusion. After a long and careful consideration of this subject, the writer has arrived at the conclusion that this process will fulfil the conditions necessary for the successful treatment of these ores. The action is rapid, continuous and complete, and the costs of running can be further minimized in many directions, not detailed in the general outline of this paper.

In operation, it is advisable to have an excess of sulphurous acid (H_2SO_3) in the solution, over and above what is necessary for the conversion of the copper oxides into their sulphites; and a day's experience of any ore will disclose the best conditions to an operator. A minor advantage of this process is that it is not based upon nicely-drawn chemical equations, with the corollary of high cost of supervision.

Dr. Edward Dyer Peters (Dorchester, Mass., U.S.A.) wrote that Mr. J. J. Muir now described the results that he had obtained in the wet treatment of copper-ores since his former communication.* Mr. Muir is evidently going through the same difficult and laborious investigations that have been undertaken, for the same purpose, in the United States during the past 25 years, and that have resulted in the two Hunt-and-Douglas methods, the McNeill process, the Van Arsdale process, and others. They nearly all of them depend upon the utilization of the sulphur in the ore or derived from extraneous ores, as a solvent for the copper the sulphur being first burned to sulphurous

* *Trans. Inst. M.E.*, 1902, vol. xxiii., page 517.

acid gas, and the gas being converted into sulphuric acid by various means. Mr. Muir finds that he can obtain from the sulphurous acid derived from a careful roasting of a very moderate amount of pyrites, a sufficient quantity of sulphuric acid to rapidly dissolve the oxidized copper contained in the roasted ore. He effects this result by forcing a blast of heated air through an aqueous solution of sulphurous acid while in contact with the ore in the leaching vats. The copper is then precipitated by pig-iron in the usual manner.

Mr. G. D. Van Arsdale* proposes a still greater economy in this direction, though he had not tried it on a working scale at the time of writing the above article. Mr. Van Arsdale finds that a heated solution of cupric sulphate, when saturated with sulphurous acid gas under pressure, yields a considerable proportion of its dissolved metal in the shape of a precipitate of metallic copper, while free sulphuric acid is formed. The solution is then used to dissolve fresh ore: the operation thus being continuous. He gives the following formulæ in explanation of this interesting reaction:

$$3\,CuSO_4 + 3\,SO_2 + 4\,H_2O = Cu_2SO_3, CuSO_3 \text{ (cupro-cupric sulphite)} + 4\,H_2SO_4. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The sulphite precipitate then usually reacts further with the free acid formed thus:

$$Cu_2SO_3, CuSO_3 + 4\,H_2SO_4 = Cu + 2\,CuSO_4 + 2\,H_2SO_4 + 2\,SO_2 + 2\,H_2O. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

He (Dr. Peters) had no doubt that Mr. Muir has already found, in common with all investigators in the United States, that there is little difficulty in selecting a method that will dissolve the copper from these low-grade quartzose ores. The sulphur in the ore will furnish the solvent required, and the ore can be easily and cheaply roasted in such a manner as to render 90 per cent. or more, of its copper-contents soluble in quite dilute acids.

The main difficulties lie in carrying out the operation rapidly and economically on a large scale, and are, for the most part, mechanical. Much money and labour has, in this country, been

* *The Engineering and Mining Journal* [New York], 1903 vol. lxxv., page 853.

expended in devising apparatus that shall burn the crushed pyrites thoroughly, and with an exactly regulated admission of air, so that a sufficiently concentrated sulphurous acid gas can be obtained from an ore low in sulphur. Still greater difficulties have been encountered in the leaching of the ore, wooden tanks, having proved unsuitable for these acid solutions, and, finally, iron vats, lined with heavy lead, have been employed. The presence of slimes, produced both by the ore itself, and by ferric salts precipitated from the solution, has been very troublesome, and at some works has called for an expensive installation of filter presses. But none of these difficulties are insurmountable, and those interested in the subject will hope to hear further results from Mr. Muir.

As regards the expense of the operation, he (Dr. Peters) did not know enough of local conditions to form an opinion about Mr. Muir's table of costs. But if the local price of fuel and labour are such that he can roast ore in a hand reverberatory furnace for 3s. 6d. per ton, the cost of fine-crushing even the hardest and toughest of schistose ores should not exceed 2s. per ton, and this should include repairs and renewals of machinery.

The Chairman (Sir Lindsay Wood, Bart.) moved a vote of thanks to Mr. Muir for his interesting paper.

Mr. T. Douglas seconded the resolution, which was cordially approved.

Mr. R. R. Simpson's paper on "Well-sinking in the Punjab" was read as follows:

WELL-SINKING IN THE PUNJAB.

By ROB. R. SIMPSON.

A number of papers have, from time to time, appeared in the *Transactions*, dealing with the subject of sinking through sands and quicksands. It may therefore be of interest to members to have an account of the method of sinking adopted, under these conditions, from time immemorial, by the natives of the North-western Punjab, India.

The annual rainfall in many parts of the province does not exceed 5 inches, and, at times, no rain falls for years together. During the hot season, all surface-supplies, streams, tanks, etc., become dry. To obtain a constant supply of water, wells are sunk through the sands of the desert to a depth of from 50 to 80 feet; at which depth water is obtained from the river Indus, many miles distant.

A representative section of the strata to be sunk through is as follows:—

	Ft.	In.
Sandy clays	17	0
Sand	3	0
Sands and sandy clays	28	0
Sand, with ½ inch pebbles	1	0
Sand and sandy clays	5	0
Water-level		
Fine sands	12	0
Coarse sands	10	0
	76	0

The first excavation is made, 15 feet in diameter, to the bottom of the sandy clays (15 to 20 feet) and is not secured.

At the bottom of this excavation, a wooden curb is placed in position. This curb (Figs. 1 and 2) is composed of eight segments, A, and has an inside diameter of 9 feet. Each segment is 24 inches wide and 12 inches deep, and the joints between the segments are strengthened by iron strapping-plates, B (24 inches by 2½ inches by ⅜ inch). Each strapping-plate is

secured to the curb by four bolts, $\frac{3}{4}$ inch in diameter. To the lower and outer edge of the curb, an angle-iron cutting-ring, C, (3 inches by 3 inches by $\frac{1}{4}$ inch) is secured by bolts. Through the middle of each segment passes an iron bolt, D (1 inch in diameter and 10 feet long). The upper ends of these bolts are attached by nuts and washers to an iron ring, E ($2\frac{1}{2}$ inches by $\frac{3}{8}$ inch by 11 feet in diameter). These bolts and the ring are intended to strengthen the brickwork to be built upon the curb.

FIG. 1. PLAN OF WALLING-CRIB.

Upon the curb thus built up, brickwork, 20 inches wide, is built for a height of 20 feet; above this, the brickwork is reduced to a thickness of 15 inches; and the building proceeds until the top of the wall is about 8 feet above the level of the surface.

Excavation is then recommenced: the sand, when dry, being removed by means of *kodalis*, and when wet by means of shovels. The kodali is the tool used by earthcutters throughout India. The blade of this tool is set at an angle of about 70 degrees to the handle, and the kodali is used somewhat in the manner of a rake. The material loosened by the blow is filled into small baskets or bags. As the excavation proceeds, the brickwork settles from its own weight, and is constantly added to at the top, which is kept several feet above the surface. Verticality is universally preserved, and sticking of the casing is never experienced.

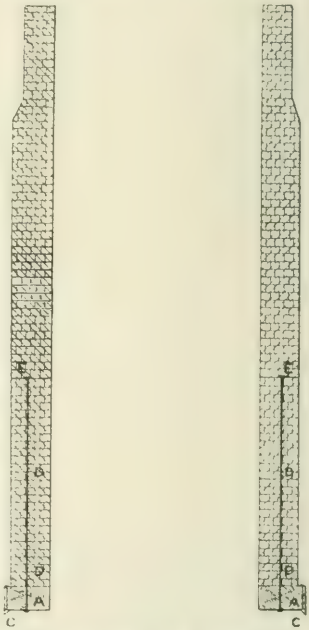


FIG. 2.—SECTION OF WALLING AND WALLING-CRIB, WITH CUTTING-RING. SCALE, 8 FEET TO 1 INCH.

The excavated material is removed from the excavation in bags by means of a rope passing over a pulley and dragged

horizontally along the surface by a gang of coolies. The pulley is supported by a rough-and-ready headgear, composed of two vertical poles, across which an horizontal pole is lashed (Fig. 3). The rope employed is three-stranded, and composed of the fibre of a reed-plant, known as *moonj*. Men are raised, standing with one foot in a loop and grasping the rope with both hands.

Water is raised by the wellknown ancient contrivance known as the Persian wheel, which consists of a broad wooden pulley, on an horizontal axis, upon which hangs a loose endless belt composed of plaited fibre-ropes. At equal intervals on this belt, earthenware-jars are fixed. As the wheel rotates, the belt and jars pass downward and enter the water, rising again to

Fig. 3. -Raising the Excavated Material.

the surface on the other side of the wheel. As the jars pass over the top of the wheel, they are emptied into a launder and the water runs away. About 90 earthenware jars are usually employed; and three jars contain about 1 gallon of water (Fig. 4). The wheel is rotated by means of a whim, driven by oxen. The barrel of the whim is cogged, and engages with corresponding wooden cogs on the periphery of a pulley keyed to the shafts of the lifting-wheel, and the latter is by this means rotated. About 3,000 gallons of water per hour can be raised from a depth of 75 feet by this appliance.

It is not found possible to sink further down than 20 feet below water-level, as, at that depth, the sand commences to run.

The rate of sinking varies from 3 to 4 feet per day. The wages paid to sinkers are 5 to 6 annas (or pence) daily, and to the coolies, 3 annas (or pence) daily.

Fairly good bricks are made on the spot at a cost of 1 rupee 8 annas (2s.) per thousand.

FIG. 4.—PERSIAN WHEEL AND HEADGEAR.

The total cost of sinking and walling a well to a depth of 75 feet is 1,500 rupees (£100), and this amount includes the cost of a Persian wheel.

Mr. W. GALLOWAY (Cardiff) wrote that the adage "There is nothing new under the sun" was once more exemplified in Mr. Simpson's description of well-sinking in the Punjab. The same process was at one time the only one by means of which mining shafts could be sunk through watery running ground. Fortunately, we are now possessed of no less than three processes (the Triger, Kind-Chaudron and Poetsch), all infinitely better,

all equally applicable where the watery or running ground is not more than 90 feet deep, while the two last are applicable to depths of 500 or 600 feet or more.

It is remarkable that the curb at the bottom of the walling employed in the Punjab sinkings is fixed to the walling above it by means of bolts, in exactly the same way as in Europe. The cutting-ring is, however, very much smaller, the corresponding cutting-shoe in the European curb being both deeper and wider, in fact occupying the whole width of the curb. Brunel employed masonry-towers of this kind at both ends of the Thames tunnel—with a diameter of 50 feet, to sink to a depth of 42 feet into the bed of the river Thames.

At Ruhrort, it took eighteen years to sink a shaft to a depth of 430 feet by means of this process. It is now happily abandoned, except in simple cases where the depth to be sunk is not sufficiently great to warrant the application of more scientific methods.

The chain of buckets for raising water from the bottom was an apparatus of great antiquity. It was employed for irrigating and other purposes, from China to Morocco. He had seen it at work raising water from a well in the neighbourhood of Algiers; and it was used in the province of Sze-Chuen, in China, for raising brine from a lower to a higher level.

Mr. H. Aitken (Falkirk) wrote that the manner of sinking described by Mr. Simpson was the same as that adopted at Grangemouth colliery about 50 years ago. The only difference was that an iron crib was used, thicker walls, heavier binding bolts (which were carried to the surface), and at intervals of 6 feet a course of sandstone was placed. The pits at Grangemouth colliery passed through 150 feet of clay, sand, mud, etc., and that entailed the use of thicker walls, etc. In sinking such pits, in future, he (Mr. Aitken) would keep very much to the same plan.*

Mr. J. P. Kirkup (Burnhope) wrote that Mr. Simpson's paper contained an interesting description of a method of well-sinking now generally employed by engineers in building the foundations of the supporting pillars for bridges crossing the great rivers of India, where their beds afford no rocky foundations upon which to build. It is interesting to learn that an old

* *Trans. Inst. M.E.*, 1902, vol. xxiv., page 209.

device has been copied and improved upon by modern engineers. Where bridge-foundations are to be placed in the deep shifting sands of river-beds, ashlar-masonry wells of octagonal section are sunk, in some instances, 80 feet below the ordinary bed of the river without resting on solid strata, and have been found effective in resisting the enormous scour of those rivers when in flood. The method adopted is to start the masonry-wall upon wrought-iron cribs with a V shaped bottom of steel as a cutting edge. These are built and set level upon the site adopted; masonry is built upon this foundation, of corresponding form; and the sinking of the wells is effected by excavating the sand from the internal area of the crib. The wall and crib steadily sink downward during the process. When the water-level is reached, the material is removed by dredgers, and drawn from shallow depths by teams of bullocks.

Fig. 5.—Sinking Foundation-wells for the Railway-bridge over the Godavery River.

When it is necessary to sink the wells in the river, the cribs are extended into double caissons and floated into position. They are then filled with masonry, and as they subside into the bed of the river, additional segments are added and the masonry built up above the surface of the water. The dredging is then effected by steam-hoists placed on craft anchored around. He had seen many of these wells built and sunk by Mr. Spring, in bridging the Godavery river; and that engineer assured him that wells had been sunk to a depth of 80 feet without varying more than a

few inches from the perpendicular. Of their stability he had ample evidence when he visited that bridge after completion, and saw the river in flood, occupying twelve spans of 300 feet each and running 56 feet deep at about 20 miles an hour. Fig. 5 affords some idea of the method. It shews dredging in progress from the top of the masonry, with a winch-engine in the background.

Mr. James Baird (Prestwick, N.B.) wrote that he had occasion some 11 years ago to sink a pit through 70 feet of mud, and in so doing adopted the method of sinking by a brick-cylinder. In the first place, a cast-iron leader or cutter was made in 6 pieces, and bolted together to form a ring, with an outside diameter of 18 feet; and this tapered inward from a sharp cutting-edge at the bottom, until at 5 feet up it measured 2 feet broad, forming a pit 14 feet in diameter. The weight of this casting was 18 tons, and upon it a brick-cylinder with walls 2 feet thick was built. Six railway-rails, 24 feet long, placed at equal distances, were bolted to the cast-iron leader; they were held in a vertical position, and built into the brickwork. When the wall approached to within 2 feet of the end of the rails, cast-iron plates, 2 feet long, 1 foot wide and $1\frac{1}{2}$ inches thick, with a hole in the centre, were slipped over each of the rails, on to the brickwork, and a cotter was driven through the web of each rail, thus binding the brickwork together. Other lengths of rails were added and fish-plated together, and the brickwork was continued as before, plates being always added at every 24 feet to bind and strengthen the brickwork. Sinking and building went on simultaneously, and the verticality of the cylinder was maintained by the method of excavating only, no weights of any description being used. The brickwork was built at the surface-level, and sunk by its own weight as the excavation proceeded. It was a common occurrence for the brickwork of the cylinder to be left 8 feet above the surface-level at night, and on the following morning it would be found to have sunk down to the level of the surface or even below it. Three shifts of excavators to one of bricklayers were employed. The excavated material was removed by means of a steam jib-crane, wire-rope, and an ordinary tipping sinking-kettle. In 5 weeks' time, the cylinder reached a depth of 70 feet, where it stuck among large boulders and further it would

not move. Other methods were then adopted of sinking the pit to the rock-head and building upward, and widening out the pit to the required diameter until the two brick-cylinders met. It was interesting to note that 70 to 80 feet appeared to be the maximum depth to which cylinders of this description could be sunk, as shewn by the various papers that had appeared in the *Transactions* on this subject. The section of the strata sunk through was as follows:—

	Ft.	In.
Soil	1	0
Sandy clay	3	0
Muddy clay	6	0
Very soft mud	2	0
Soft dark mud	45	0
Sandy mud	3	0
Soft brown mud	9	0
Gravel-bed	1	6
Large boulders	2	0
Total	72	6

The CHAIRMAN (Sir Lindsay Wood, Bart.) moved a vote of thanks to Mr. Simpson for his interesting paper.

Mr. T. DOUGLAS seconded the resolution, which was cordially approved.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING,

HELD IN THE WOOD MEMORIAL HALL, NEWCASTLE-UPON-TYNE, OCTOBER 10TH, 1903.

MR. W. O. WOOD, PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on September 26th and that day; and also the proceedings of the Council of The Institution of Mining Engineers on September 2nd.

The following gentlemen were elected having been previously nominated:—

MEMBERS—

MR. SYDNEY HORSLEY, H.M. Inspector of Mines, Charters Towers, Queensland, Australia.

MR. WALTER MAURICE REDFEARN, Mechanical Engineer, Horden Colliery, Castle Eden, R.S.O., County Durham.

MR. JAMES BERTRAM SAMPLE, Mining Engineer, Harraton Colliery, Chester-le-Street, County Durham.

MR. JOHN JAMES WHITEHEAD, Mining Engineer, P.O. Box 6407, Johannesburg, Transvaal.

ASSOCIATE MEMBERS—

MR. CLARENCE ADRIAN BISHOP, Mooi River, Natal, South Africa.

MR. JAMES THOBURN CACKETT, 24, Grainger Street West, Newcastle-upon-Tyne.

MR. ALEXANDER MILLER, Wollongong, New South Wales, Australia.

MR. DAVIDGE PAGE, Clun House, Surrey Street, Strand, London, W.C.

STUDENT—

MR. JOHN ALLAN EADIE, Jun., Apprentice Mining Engineer, Eller Bank, Harrington, Cumberland.

SUBSCRIBER—

MESSRS. BRUNNER, MOND & COMPANY, Limited, Northwich, Cheshire.

REPORT OF THE DELEGATE TO THE CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, SOUTHPORT, 1903.

The report of the proceedings of the Corresponding Societies' Committee of the British Association for the Advancement of Science, and also that of Mr. John Gerrard, the delegate representing the Institute was read as follows:—

WORSLEY, MANCHESTER,
October 7th, 1903.

TO THE PRESIDENT AND COUNCIL OF THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENTLEMEN,

I attended the two meetings of the Conference of Delegates of Local Societies held at Southport, on September 10th and 15th.

There was a discussion upon convincing the "man or boy in the street" as to the practical advantages of a knowledge of science. A resolution was passed, that it is desirab[illegible] at scientific workers, and persons interested in science, be so organized that they may exert permanent influence on public opinion, in order more effectually . . . to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress . . .

The following papers are of some interest to the members:—

"Presidential Address." By Sir Norman Lockyer.
"Presidential Address (Section C—Geology)." By Prof. W. W. Watts.
"Terrestial Magnetism in its Relation to Geography." By Captain Ettrick W. Creak.
"The Equipment of the Manchester Municipal Technical Institute." By Mr. J. H. Reynolds.
"Liquid Fuel." By Mr. A. M. Bell.
"The Ventilation of Tube-railways." By Mr. J. W. Thomas.
"Presidential Address (Section F—Economic Science)." By Mr. Edward W. Brabrook.
"The Preservation, Seasoning, and Strengthening of Timber." By Mr. W. Powell.

I am, Gentlemen,
Yours faithfully,
JOHN GERRARD.

DISCUSSION OF THE "REPORT OF THE COMMITTEE UPON MECHANICAL COAL-CUTTING."

Mr. T. E. Forster (Newcastle-upon-Tyne) said that the object which the Committee had in view when the *Report* was prepared was that it should give as much general information on coal-cutting, as could be collected up to the date of its publication; not necessarily information of a scientific character, but such as would be of use more especially to those who had not had any long experience with coal-cutting machines. Some 30 collieries were visited in all parts of Great Britain, where coal-cutting machines were being worked, principally in Scotland, the Midlands, Yorkshire and West Lancashire. He was of opinion that mechanical coal-cutting was likely to increase in the near future. The quantity of coal got by coal-cutters in this country had risen from a little over 3,044,321 tons in 1901 to 4,161,202 tons in 1902, or 36 per cent. in one year.* It was interesting to note that the largest output was from the Yorkshire district, with 1,349,997 tons from 129 machines; the Midland district came next with 812,132 tons from 93 machines; the two districts of Scotland produced 756,813 tons with 85 machines; Newcastle-upon-Tyne district 249,291 tons with 23 machines; and Durham 223,109 tons with 30 machines, or a total for the counties of Durham and Northumberland of 472,400 tons with 53 machines. One could not help noticing, in comparison with its size, that this district was considerably behind other districts in the matter of mechanical coal-cutting. Whether it was that there was not the necessity for it that existed in the south, or that the seams there were more suitable, he was not prepared to say; probably, the labour-conditions were not so well suited to mechanical coal-cutting as in the Midlands or in Scotland. The Committee called attention to the fact that the arrangement of the system of working was more than half the battle. If a suitable coal-cutter for the work was selected and put down with proper appliances, there could be no doubt that it would work satisfactorily, but unless they arranged the labour and fixed the hours and conditions properly, it was of very little use

* *Mines and Quarries: General Report and Statistics for 1902*, 1903, pages 114 and 115.

to adopt mechanical cutting. Although backward as regards the number of machines in use, the produce per machine showed that this district stood in a favourable position. Staffordshire showed the highest produce per machine, 11,600 tons; Northumberland came second with 10,800 tons, being a little better than Yorkshire at 10,400 tons. Judging from one's observations of coal-cutting in Northumberland, it was not the thickness of the seams that tended to the production of the greater quantity, but more attention had probably been given to the nature of the work, and to keeping the machine always at work. In some cases in the south, the machines were not kept continually at work, and as they were only occupied about half the time, the capital charges and interest came out much higher.

Mr. W. R. Dakers (Tudhoe Collieries) referred to a statement in the *Report* that "the costs of motive power, repairs, and interest on capital, which appear, under average conditions, to amount to about 4d. or 6d. per ton raised."* Elsewhere it was mentioned that "the highest cost under these heads, which had been ascertained at the collieries visited, is 1s. 2½d. a ton, and this appears to be largely due to the use of unsuitable plant; and in many instances it is put at 4d. per ton. It may be asserted with confidence that, in most cases, it will be covered by 7d. a ton with some margin on the right side."† Two examples of machines were referred to, in the Appendix, in the county of Durham:—At No. 20 colliery,‡ there was an output of 6·25 tons per man per shift, with a cost for other labour in face of 1s. 0·17d. per ton; while at No. 31 colliery,§ with an output of 2·87 tons, the same labour-cost was 9·75d. It was difficult to reconcile these figures.

Mr. T. E. Forster, with reference to the cost of repairs, said that it was difficult to find collieries where everything was accounted for separately, and in the case of the high figure of 1s. 2½d. per ton, it was mentioned that this appeared to be largely due to the use of unsuitable plant. From 4d. to 6d. per ton was the figure quoted by users of machines, although they could not always substantiate the figures. No doubt, after making all the enquiries, the Committee had come to the conclusion that 7d. per ton might be taken as a safe figure;

* Page 4.
† Page 31.
‡ Page 39.
§ Page 41.

possibly 6d. or even 5d. might cover it, but it would depend on the seam. It was difficult to get at the exact figure per ton: and it would probably be fairer to quote a price per square yard. Referring to the labour-cost and the output per man per shift, he would not like to say how the difference arose: the figures were all certified by the colliery-managers who supplied them, and no doubt an explanation would be forthcoming. There was a great deal of difference in the cost of filling the coal: at some collieries, half the filling was done by putters, in others it was filled by hewers at datal wages, and this was the principal difficulty met with in a district in which they had not defined who was a filler, and what he was to be paid.

Mr. R. Hood Haggie (Derby) wrote that the *Report* went so fully into all the details that it was difficult to add anything of interest. He noticed that, with the exception of bar-cutters, nearly all the tools were chisel-shaped, and the *Report* read as though disc-machines could only use chisel-tools. He had recently tried some pick-pointed tools in a disc—using about half pick and half chisel—and he found a great advantage in doing so, as it reduced the current on a 500 volts circuit by 5 ampères. In this case, the top of the band, in which the holing was made, was friable and the bottom tough. He had found that the mixing of pick and chisel-tools on the disc in some places was advantageous, as it increased the time-interval, before it became necessary to change the set. In electrically-driven coal-cutters one of the chief causes of breakdown of armature and gearing lay in the switch, and that might be due either to the design or to the manipulation. Manufacturers gave too little thought to it, and machine-men did not seem able to grasp the necessity of starting the motor slowly. Unfortunately the space afforded to the switch was very limited, and did not allow for the attachment of all the safety-devices which one would like to utilize. There was seldom room to put in a switch, with ample resistances and with the handle arranged so that however quickly it could be pushed over the contact-arm took its proper time, and arranged with a quick break-action, a no-voltage release and an overload cut-out. Yet all these devices were deemed necessities for a motor on the surface, where it was working under the best of conditions. Undoubtedly the motor was placed in the most trying position on a coal-cutter, and a reli-

able switch was so essential to its satisfactory working that he thought some space should have been reserved in the *Report* for that subject.

Mr. Fred W. Hurd (Bothwell) wrote that he had read with great interest the Report of the Committee: from the introduction right through to the appendix it was a valuable and thoroughly practical piece of work, and anyone introducing coal-cutting machines into a mine could not do better than take this *Report* as a handbook on coal-cutting and work up to the book. It was gratifying, from a machine-maker's point of view, to see that stress was laid upon the importance of having the machine-face straight, and having stables cut at each end of the face. These points did not generally receive the consideration that they deserved. The description given of the Hurd machine, and its special features, was a very fair one; but he desired to add the following particulars: (1) With a bar, $3\frac{1}{2}$ feet long, the machine did make its own pavement. (2) The cuttings were cleaned out as well as, if not better than, with any other type of machine. (3) It was an open question whether or not it was better to cut across a stratified material vertically instead of horizontally: there was undoubtedly less friction when cutting vertically as shewn by power-diagrams. (4) The small machine was working in a seam, which was in some places only 17 inches high. (5) The compressed-air machine referred to was working, and was probably the simplest and strongest machine ever put into a pit. And (6) it was only in rare instances that the cutter-bar and direction of rotation of the motor required alteration when back-cutting.

The three-phase cutters referred to at Ackton Hall, were Hurd machines, and several others had lately been set to work at this and other collieries with excellent results. At the machine, three-phase current was a distinct advantage, as no brushes with their multiplicity of parts to get out of order were required. From the generator to the machine, however, the simplicity disappeared, and the heavy starting current was a disadvantage, as it prevented the use of a fuse-wire of a section small enough to be considered a safeguard for a motor, as in a direct-current plant.

Referring to the tables, he was naturally delighted to find that the Hurd machine showed the greatest saving per ton over hand-worked coal. The seam was recognizable, and he must in

fairness say that credit for the low cost of holing was due in great part to the clever way in which the machine-face was set out. The expense of flitting was reduced to a minimum, in fact he had known the machine cut between 20 and 30 yards at one end of the face, and then be flitted and cut 40 yards at the other end, all in one shift of 9 hours. The cost of flitting was overstated in the *Report*, and the subject should receive special attention in each case. The tables would have been more complete, if, in the case of electrical machines, the ampères taken as well as the voltage had been given.

Mr. H. F. Bulman (Barcus Close), with reference to the figures of costs, wrote that the object desired was to show what saving, if any, is obtained by the use of machines. As stated in the *Report*,* these figures were supplied by the colliery-managers in the form and under the heads stated in the schedule; and, therefore, should be reliable, as showing the relative cost of machine-cutting *versus* hand-work in each case. But it is not always easy to differentiate exactly the "labour in face," and in some cases, probably, the figures cover more or less shift-work and stone-work than in others.

As regards the discrepancy referred to in connection with No. 31 colliery, it is explained in the foot-note that the cost of stone-work is not included in the figure given, and that when this is added, there is practically no saving over hand-work.†

As to the cost of repairs and motive power, and interest on capital, the larger the output from the machines, the smaller will be the cost per ton of these upstanding charges. When continuous-current electric coal-cutters are first put into the hands of inexperienced men, the cost of repairs, owing to burnt-out armatures and other mishaps, is sometimes very high. There is a wide variation at different collieries, but such figures, as could be obtained, justify the statement in the *Report*, that in most cases it is covered by 7d. a ton.

If colliery-managers, who use machines, would give the members the benefit of their experience, by supplying particulars similar to those contained in the schedule, it would form a valuable supplement to the *Report*.

The President (Mr. W. O. Wood) said that, as there was a considerable variety and thickness of seams, so there was a great

* Page 3.

† *Report*, page 41.

variety of machines employed, which made it difficult if not almost impossible to obtain fair comparisons. Mechanical coal-cutting was only in its infancy, and in some cases the power utilized was also applied to other purposes simultaneously: in the case of compressed air, sometimes to hauling and pumping-engines, and it was difficult to estimate with any degree of accuracy what was the cost of the power supplied to the coal-cutting machine. There might be some cases where the power was used only for coal-cutting, but even there the figures would not be quite so reliable as one might like to have them: for, as it was pointed out in the *Report*, mechanical coal-cutting in this district had only attained the experimental stage. He thought that the Committee had performed a most useful work, and had compiled a large volume of extremely valuable information, and, so far as the present state of the mechanical coal-cutter was concerned, the *Report* was as good and clear an account as the members could have. When mechanical coal-cutting came more generally into operation (as no doubt it would) and they adopted the methods of working alluded to by Mr. Forster, and got their labour into order (and that was the important factor), he did not see why the counties of Durham and Northumberland should not show as good an account of themselves in coal-cutting as they had done in everything else. The members were exceedingly obliged to the Committee for their interesting *Report*, and he had pleasure in moving a very hearty vote of thanks to them for their services.

Mr. W. R. Dakers seconded the resolution, which was cordially approved.

Mr. David Burns' paper on "The Anthracitation of Coal" was read and discussed.

Mr. Edward S. Wight's paper on "Bore-holes for Pumping Purposes" was read as follows:

BORE-HOLES FOR PUMPING PURPOSES.

By EDWARD S. WIGHT.

The writer is induced to lay before the members a description of a method by which a bore-hole can be used for pumping purposes; not as an engineering feat, but rather to shew that the water generated in the distant workings of a mine may in many cases be delivered direct to the surface, thus saving long ranges of pipes underground and probably several handlings of the water.

At one of the mines under the writer's charge, the pumping was done in three stages: No. 1 pump being adjacent to the shaft-bottom, No. 2 pump being 1,200 feet inbye and No. 3 pump a further distance of 330 feet inbye. No. 2 is 60 feet lower than No. 1 pump, and No. 3 is 50 feet lower than No. 2 pump. The water was pumped from one pump to the other, and No. 1 pump forced the water direct to the surface. As No. 1 pump was too small to deal with the water made at its own level, and also that delivered to it by No. 2 pump, within 8 hours, this involved a second shift of pumping.

To avoid using a larger pump instead of No. 1 pump, and also a larger column of pipes to the surface, it was resolved to put down a bore-hole on the west side of the Waikato river, so as to enable No. 2 pump to force the water direct to the surface. The necessary survey being made, a contract was let to put down a bore-hole and line it with a pipe, 5 inches in diameter: the price being 4s. 6d. per foot for labour only, for a depth of 242 feet.

It was known that down to a depth of about 100 feet the bore-hole would be made in quicksand, consequently a pipe 6 inches in diameter was driven through this, and through it a pipe 5 inches in diameter would be telescoped. To enable this to be done, it was necessary to slightly turn down the couplings of the pipes, 5 inches in diameter, in order that they might pass through the pipes, 6 inches in diameter. At the bottom of

the quicksand, 115 feet deep, a log of wood, 18 inches thick, was struck on one side; and, to prevent the sand from running, it was necessary to drive the pipes, 6 inches in diameter, through the log after it was chipped away sufficiently. [Samples of these chips were exhibited to the members.] It was afterwards found that the driving of the pipe past the log had deflected the hole slightly, and to such a degree that after the hole was pierced into the workings the pipes, 5 inches in diameter, would not travel past the deflection, on account of the couplings being so neat a fit. An endeavour to procure pipes 4½ inches in diameter in the colony proved fruitless: the hole was therefore lined with pipes, 4 inches in diameter. These slipped down with great freedom, so that the deflection of the bore-hole could not have been very great.

The water from No. 2 pump is now forced direct to the surface through the bore-hole, and it is intended shortly to work No. 3 pump, at which station there is only a small quantity of water, as a hydraulic, taking the power from the column of No. 2 pump. By this arrangement, the water is now easily pumped out in 8 hours, and the services of two men dispensed with, effecting a saving of 17s. per day. Probably the same result could have been obtained by increasing the size of No. 1 pump, but considering the circuitous route of the pipes from that pump to the shaft-bottom, and other conditions prevailing, it was considered best to adopt the bore-hole, sufficient pipes being released in the distance of 1,200 feet to No. 2 pump to almost pay for the work.

A brief description of the Gilberd boring-machine, used for putting down the bore-hole, may prove of interest. It is a percussive rotary machine, using an ordinary chisel on pipe-rods, through which water is pumped to bring up the dèbris. The stroke is obtained by a hempen rope wound around a friction-drum, the attendant holding the rope-end until the necessary lift is attained, then suddenly releasing it and allowing the rope to surge on the drum, and thus any length of stroke can be obtained. The turning motion of the drill is produced by clamping a toothed wheel upon the rods, the wheel gearing into a fluted column, about 5 feet high; and this column is made to revolve at a speed of one revolution of the rods to about every 5 strokes of the chisel. When starting, the toothed wheel is set

near the top of the fluted column, so that 4 feet or more can be bored before it need be raised again. It is claimed that the machine is capable of boring through almost any rock, and it has done rapid work when boring for water, where a record of the section of the strata is only a secondary consideration. In Auckland, the Gilberd machine has bored a hole, 3 inches in diameter, through the sandstones of the Waitemata, 1,135 feet deep, in 8 weeks; in the same locality, a hole, 6 inches in

Fig. 1.—The Gilberd Boring-machine.

diameter, was bored to a depth of 400 feet in 15 days; at Otahuhu, 9 miles from Auckland, a hole was bored to a depth of 945 feet, at a cost of £105, exclusive of coal; and at Huntly, a hole, 145 feet deep, was bored in 1½ days, through quicksand and 30 feet of coal. The best record, however, was through alluvial at Turua, Thames Valley, where a hole, 3 inches in diameter, was bored to a depth of 214 feet in 6 hours, 74 feet of which was done in 1 hour. In each instance, 8 hours constituted a day's work, the labour attending the machine being

a man, and a lad, 19 years of age. The whole of the gear, including engine and boiler, but not including the derrick-pole, is mounted on a wagon, and can be easily removed on level ground by two horses. It takes about 4 hours to set up the machine ready to commence boring.

Fig. 1 shews the general arrangement of the machine. The pump, fixed on one side, is worked from a disc on the end of the main shaft. The suction-pipe disappears at the left-hand of the picture. The delivery-pipe to the rods come away overhead to the downward bend on which is fixed a flexible pipe, and in the picture this comes down nearly to the ground, forming the letter U, and disappears out of the top of the picture, where it connects on the pipe-rods. The overflow of water, etc., from the bore-hole is carried through the horizontal pipe a little above ground-level, and is delivered into the trough used as a settling-tank, so that the water can be used over again when it is not handy to get supplies. A fine sieve is kept under the pipe-end to collect samples of the boring. The engine has a cylinder $4\frac{1}{2}$ inches in diameter, by 8 inches stroke.

To obtain an accurate section of the strata, skill in handling the machine is essential; and when plenty of clear water is obtainable, an accurate section is procured, but when the water has to be circulated, the changes are not so easily marked.

Although this particular instance of the use of a bore-hole for pumping water is only on a small scale, the writer is of opinion that there are many instances where a bore-hole might be used to advantage, and long ranges of pipes dispensed with. He further holds the opinion that probably there are instances when it might be advantageous to put down two holes, one for water and the other for steam, and by placing a boiler at the top of the holes a long transmission of power by some other means underground would be obviated.

As previously stated, this paper is not prepared as a record of an engineering feat, but merely to shew what in actual practice one is sometimes by force of circumstances led to perform, and the writer hopes that it may prove of interest to many of the members.

Mr. Frank Coulson (Durham) wrote that communication between the surface and underground workings by means of bore-holes is of considerable importance, either for the delivery of water as adopted by Mr. Wight, or for conveying power: whether compressed air or electricity. The air-compressors may be placed on the surface at the top of the bore-hole and driven by electricity generated at any suitable point, probably at the colliery, thus saving the great length of tubes frequently necessary to convey compressed air to the working-face. By this method, also, electricity might be conveyed into fiery mines to a power-station, and thus obviate the danger of conveying the current by wires underground. Probably it would be necessary to enclose the underground power-station, and force air down the bore-hole, so as to prevent any gases or air from the mine from coming near the motor or the short length of electric wire in the mine. Bore-holes might also, in some cases, be used to drain gas from old workings. An argument against the use of such bore-holes is that they might possibly be damaged by the movement of the ground caused by the working of the coal.

The President (Mr. W. O. Wood) moved a vote of thanks to Mr. Wight for his interesting paper.

Mr. M. Walton Brown seconded the resolution, which was cordially approved.

Mr. M. Walton Brown read the following description of "The Neu-Catrice Portable Electric Lamp for Miners":—

THE NEU-CATRICE PORTABLE ELECTRIC LAMP FOR MINERS.

This lamp (Fig. 1) consists essentially of a box or case of sheet-lead containing two accumulator-cells made of transparent celluloid or semi-plastic indiarubber. Each accumulator contains one positive and two negative plates of the Etampé type. The united elements constitute a small battery of a mean voltage of 3·9 volts, sufficient to supply, for 15 consecutive hours, a small incandescent lamp with a constant illuminating-power of about 1 candle. In order to avoid the spilling of the liquid, the electrolyte of these accumulators is fixed by a special process, in such wise that the lamp may be used without risk in any position whatever.

On the lid of the case is fixed an ebonite-base which supports a protecting globe of extremely thick glass, and within the thickness of the ebonite-base a small opening is cut to allow of charging the cells. A small movable shutter masks this aperture, and is so combined with a switch that the lamp can only be lighted when the charging-plug is withdrawn and the shutter is closed. This arrangement is adopted with the view of preventing the current for charging the accumulators (which is at a minimum potential of 5 volts) from being passed through the lamp.

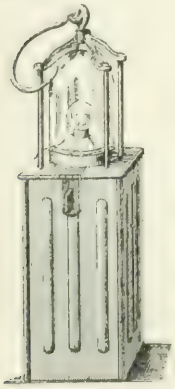


Fig. 1.

The lid of the case is locked by a leaden rivet which can be impressed with a stamp, so as to ensure it against being idly tampered with by persons who are not entrusted with the duty of keeping the apparatus in order.

Upon the ebonite-base is also fixed a socket to carry the end of the bulb of the small lamp. The upper portion of the protecting-globe is held fast (with the interposition of a rubber ring) by a cover, and the latter is connected with the lid of the sheet-steel case by three pillars or poles, and, finally, a hook rivetted to the upper part of the steel cover completes the lamp. The protecting-globe is, in regard to one half, painted with a semi-translucent white

varnish which acts as a reflector, while allowing a certain amount of light to be diffused backward.

This portable electric lamp is made in two sizes: one weighing 3 pounds 14 ounces, gives 0·8 candle-power during 11 hours, and the other weighing 5 pounds gives 1 candlepower for 15 hours. The respective dimensions are, for the small lamp: 10 inches high and $2\frac{3}{8}$ inches square: and for the big lamp: 10 inches high and 3 inches square. The lamp consumes less than 3·5 watts per candle-power and lasts for 500 hours.

The charging-plug consists of a block of ebonite, which bears on one of its faces two brass springs: and this arrangement is so devised that any possible error in polarity is obviated.

To recharge the lamps a charging-table consisting of 20 or 40 compartments is used, according as the available electromotive force is 110 or 220 volts: and a small switchboard comprizing a regulating rheostat, an ammeter, a minimum cut-out, a two-ways commutator, and a 32 candlepower lamp used as a resistance, absorbing at the commencement of the discharge the excess of voltage which would rapidly deteriorate the small lamps. When the accumulators are recharged, before removing the charging-plugs they are discharged for 20 minutes on to the 32 candle-power lamp upon the switchboard.

Above each compartment is the charging-plug, fixed to one of the ends of a pliable cord with two leads: the other extremity of this cord is attached to the two-ways commutator. In this manner the current may be either sent through the plugs, or diverted through a resistance, equivalent to that of the accumulators, coiled round the base of this very commutator: this arrangement allows of the recharging of any given number of lamps, the current intended for those which are not at hand being absorbed by the corresponding resistances.

The charging-current should be of 1 ampère, and the duration of charge about 12 hours. The lamp is kept in the lamp-room from the time when the workman comes to bank (2 p.m.) until he calls in to fetch it away again the next morning (5 a.m.). For a load of 500 lamps a shunt-wound dynamo of 110 volts and 25 ampères capacity is required.

The lamp is closed by means of a leaden rivet, and the lid should only be raised every four or five days, in order to pour a few drops of acid into the cells. The shutter which masks the

charging aperture is also closed by a leaden rivet: and it is taken off daily for purposes of recharging.

TABLE I.—EXTRACT FROM THE REGISTER OF THE LAMP-ROOM AT NO. 1 PIT OF THE BRUAY COLLIERIES, PAS-DE-CALAIS.

Daily mean during April, 1903.

Number of lamps in good working order	504
Number of lamps taken down the pit daily	504
	Per cent.
Lamps, which have completed the shift	96·73
Lamps unusable :—	
For want of voltage	0·72
Worn-out bulbs	1·52
Defects in switches	0·07
Defective connections	0·72
Unspecified accidents	0·24

For the past 15 months, 500 of the larger sized lamps have been in use at No. 1 pit of the Bruay collieries, and the annexed table will enable the members to form some idea of the good results which have been achieved. The cost of maintenance amounts to almost exactly ½d. per diem.

The PRESIDENT (Mr. W. O. Wood) stated that while he was not familiar with the Neu-Catrice lamp, he had in regular use at Murton colliery, some 1,400 Sussmann portable electric lamps. This style of lamp presented considerable advantages, as it was absolutely safe in gaseous atmospheres and very reliable. The bulbs had a life of about 700 hours. The cost was about 3s. per lamp per annum more than that of the ordinary oil-lamp, but he thought it was quite worth while to pay this amount if it was only in the shape of an insurance against explosion, and in fiery mines it was an immense advantage to have a lamp of this description.

DISCUSSION OF MR. W. LECK'S PAPER ON "AMBULANCE-INSTRUCTION AT MINES."*

Surgeon-Major GEORGE A. HUTTON (Honorary Organizing Commissioner of the St. John Ambulance Association) wrote that when the final report of the Royal Commission appointed to inquire into accidents in mines was issued in 1886, he was deputed

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 354.

by the St. John Ambulance Association, to conduct an Ambulance Mission in the counties of Durham and Northumberland. His first meeting was held at Bishop Auckland, with the then Bishop of Durham (Dr. Lightfoot) in the chair, who said that "he felt that he was assisting in a work of great beneficence and usefulness, and he hoped that classes would be formed in every colliery-village throughout the county." He (Mr. Hutton) said that no doubt that ambulance-instruction interwoven into the daily life in all mining villages, would add brightness, kindness and active benevolence to that life—it would tend to sweeten life—to make it more endurable—more hopeful—more Christian in all the centres of toil and industry. He then recommended that classes of 30 men should be formed at every colliery. The result of this meeting was that a very large number of classes were started all over Durham county in 1887; and as an outcome of these classes, a large gathering of some hundreds of ambulance-men, who had undergone instruction, was held in October, 1888, in Beamish Park, county Durham, when various ambulance-evolutions were gone through.* He said at the close of the drill, in congratulating the men on the practical way in which they had shown their ambulance-knowledge, that we had established hospitals for the sick and injured all over the country—we had also in several places started convalescent homes, and in some few places homes for the incurable; but there was still one more link to complete the chain of assistance to the injured—a link which, if omitted, led to much pain and suffering, and that was this ambulance-link, and he invited all to assist in forging this link, and in doing so, to make it a lasting and durable link—in short, a permanent work among them.

He hoped, therefore, that Mr. Leck's paper might largely assist in reviving the classes throughout the mining districts of the country. He had always found it most desirable that the syllabus of the lectures issued by the St. John Ambulance Association should be strictly followed, and five lectures were quite enough, especially for miners, with perhaps an additional lecture summarizing the course, given a week after the last lecture, and previous to the examination.

With regard to Prof. T. Oliver's remarks on accidents from electricity, he represented this matter to the central committee

* *Illustrated London News*, October 20th, 1888.

in London some time ago, and he had been told by the chief secretary of the St. John Ambulance Association (Sir Herbert Perrott, Bart.) that an addition to the syllabus referring to accidents from electricity would be added.

The best time to commence the course of instruction is in October or the beginning of November, so as to get the course over before Christmas, or if more convenient, after the Christmas holidays in January and February, so as to hold the examination not later than April or May. The summer he had always found better devoted to outdoor ambulance gatherings in the form of demonstrations of work and competitions. The main object of the instruction should be to make the work practical, and there were about five cardinal points that he might emphasize: (1) Broken bones: (2) arrest of bleeding: (3) burns by fire: (4) drowning, and the accidents likely to occur in the industries of the various districts where the instruction was given, such as noxious gases, electricity, etc.: and (5) the careful removal of the injured by hand, on stretchers, in horse-ambulances by road, by railway, etc.

As far as the mining districts of Great Britain were concerned, as a general rule, he considered that the system of detached classes would be found most convenient. Mines being studded all over the county, the classes could be more easily managed in this way by direct communication with London, and having visited a large number of these mines in past years, he could speak with some authority on this part of the work.

In the opening sentence of Mr. Leck's paper the author said that "ambulance-instruction at mines may, at first sight, appear to many persons as having but a remote connection with the specific business"* of the members, but looking at it as an economic question, apart from humanity, there was no doubt that carried out on practical and systematic lines, it would lead to (1) reduction in the death-rate in mines, (2) reduction in sickness and injury, and length of time on the sick-list and (3) the saving of the funds of all societies formed for dealing with mining distress caused by accident. Considered in this light, Mr. Leck's paper was well worth the careful attention of the members, and it was to be hoped that a large number of ambulance-classes would be started at collieries and mines in the forthcoming winter.

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 354.

Mr. William Leck (H.M. Inspector of Mines, Cleator Moor) wrote that Mr. A. H. Stokes (H.M. inspector of mines for the Midland district) stated in 1888, that ambulance-instruction had obtained a substantial footing in his district. At that time there were in the Midland district 2,924 persons either undergoing a course of instruction or already qualified to render first aid to the injured.*

The practical remarks of Surgeon-Major Hutton, drawn from the experience of a long and busy life, deserved the careful consideration of every one interested in the promotion of ambulance-work. He agreed with him that, as a general rule, colliery-classes could be best administered by means of detached classes. The weak point with reference to centres was that an apparently strong organization might suddenly collapse, if the prime-mover in the matter dropped out of the work. This regrettable result, the Chief Secretary of the St. John Ambulance Association had not infrequently had occasion to deplore, but it was counteracted when the classes were in direct communication with head-quarters. On the other hand, an aggressive centre would, in his opinion, do more missionary and extension-work than any other form of organization which had yet been tried.

He took this opportunity of correcting a slight error in the foot-note on page 370,† where the fifth line should read "to which the officials of the Whitehaven Colliery Company." This did not affect the deduction, immediately following, and it had been a source of supreme satisfaction to him that the ambulance-movement in West Cumberland had been the means of bringing together employers and workmen in harmonious unison, for the furtherance of one common and highly commendable object, the alleviation of human suffering.

DISCUSSION OF MR. W. M. BREWER'S PAPER ON "THE ROCK-SLIDE AT FRANK, ALBERTA TERRITORY, CANADA."‡

Dr. Eugene Haanel (Superintendent of Mines, Ottawa) wrote that the summary of the official report on the recent land-slide at Frank, Alberta, by Messrs. McConnell and Brock, was as follows: —

* *Annual Report*, 1888, page 5. † *Trans. Inst. M.E.*, 1903, vol. xxv.

‡ *Trans. Inst. M.E.*, 1903, vol. xxvi., page 34.

As to the nature of the disaster at Frank there cannot be a doubt. It was a rock-slide (Bergsturz) of colossal dimensions, one of the largest on record.

Turtle Mountain, part of which fell away, is a sharp Rocky Mountain ridge, which, with the exception of a short talus-slope at the base, rises very steeply in a succession of cliffs, to a height of 3,100 feet above the valley. It is the central and highest peak of this ridge, which broke away. The mountain consists of Cretaceous sandstone or shales at the base, with limestone (part at least of Devonian age) forming all the upper portions. The limestone has been thrust over the newer rocks along a fault-plane by the mountain-building forces. The Cretaceous beds are overturned, dipping into the mountain at an angle of 82 degrees, while the limestones have a westerly dip of 50 degrees. The basal beds of the limestones have been much folded and crumpled by friction, due to thrusting forward of the series along the fault-plane. They form a very weak base for the precipitous mass above. The mountain is thoroughly dissected by fracture and jointing-planes.

On the morning of April 29th, 1903, a mass of rock surrounding the central peak, ½ mile square and 400 or 500 feet thick, suddenly broke away and rushed with great velocity into and across the valley, destroying everything in its path. Fortunately, the greater part of the town lay outside the course of the slide, but much property was destroyed and 70 lives were lost. Over 1 square mile of pleasant valley was transformed into a dismal waste of rock.

The motion of the slide-rock was complex in detail, but as a whole resembled that of a viscous fluid. The distance from the top of the break to the foot of the slide, following the slope, is about 2½ miles. The average thickness of the slide-rock across the valley, along the centre of the slide, is 65 feet; the deepest portion of the slide is about 150 feet thick, and the average over the whole slide cannot be less than 45 feet. A rough estimate of the amount of material dislodged is about 40,000,000 cubic yards, representing in weight about 90,000,000 tons.

In the Alps, destructive land-slides have been quite frequent, but are exceedingly uncommon in the Canadian Rockies. None at all approaching this one in size has ever been recorded.

The slide was due not to a single cause, but to a combination of causes. The primary cause was undoubtedly the form and structure of Turtle Mountain, already referred to. The huge mass was in a state of unstable equilibrium, possessed a weak base, and was thoroughly traversed by fissure and jointing-planes, in which water and frost were continuously at work removing, one by one, the supports which held it in place. The heavy precipitation of the last few years accelerated this process. Recent earthquake-tremors, particularly that of 1901, no doubt hastened the time of final disruption. The opening up of large chambers in the mine, situated under the base of the mountain, may have been a contributary cause, by allowing slight readjustments in the strata forming the hanging-wall of the seam, producing jars that might dissever some of the few remaining bonds. The heavy frost on the morning of the slide, which followed hot summer-like days, appears to have been the force which severed the last thread and precipitated the unbalanced mass.

The zone, surrounding the cavity left by the mass which broke away, is excessively fractured and is doomed to fall. The portion behind the break

and south of it is not dangerous, as it has a free course and is already falling in small individual blocks. The north peak and shoulder overhanging the town are, however, dangerous. They threaten the town and the mouth of the mine. Their condition now is very similar to that of the central peak before it fell away. There is always a remote possibility of a sudden movement, although the commencement of the movement is more likely to be gradual. In course of time, ordinary atmospheric weathering will bring down this threatening mass, but a slight earthquake-shock, a succession of seasons with unusually heavy precipitation and rapid temperature changes, or the closing of the chambers in the mine, after the coal has been "drawn," perhaps long after the inhabitants of the town have lost all dread of any impending disaster, may precipitate it suddenly in a second destructive slide.

Since this possibility must always overhang the town, it certainly seems in the interest of safety that it be moved a short distance up the valley, beyond the reach of danger.

Mr. W. D. L. Hardie (Lethbridge, Alta., Canada) wrote that he visited Frank, some two or three days after the disaster, and the rumbling rocks, even then, created a noise and roar that was simply appalling; and the great clouds of dust made the spectacle more wonderful.

He had a long conversation with Mr. D. M. McKenzie and others of the 17 miners, who were entombed; and they all practically gave the same statement, as Mr. McKenzie, which had been reproduced in Mr. Brewer's paper. He thought that Mr. McConnell's estimate of about 90,000,000 tons of rock was a very modest one. He had seen statements running as high as 200,000,000 tons, and would not say that even these large figures exaggerated the extent of the slide. The immensity could not be conceived or imagined without a visit.

The members might form an opinion as to the cause of the disaster if they more fully understood the method of mining adopted there, and the relation of the seam being worked to Turtle Mountain. Fig. 1 (Plate IV.) gives an idea of the method of mining, and Fig. 2 (Plate IV.) shows the relative positions of the mine and Turtle Mountain. Fig. 3 (Plate IV.) is a section of Turtle Mountain, showing approximately the portion of the mountain that slid into the valley. The coal-seam does not run into the mountain, but strikes nearly parallel with it, the cover becoming thicker as the mine advances in the seam. At 5,000 or 6,000 feet from the mine-entrance, the seam extends several hundred feet above the day-level, while there is very little cover at the mouth of the level,

Since the disaster, the Canadian-American Coal and Coke Company have done a little work at the old mine; they have put in a day-level at the opposite side of the valley, and they have sunk a shaft in the coal at B (Fig. 2, Plate IV.). At the time of the slide the Company were shipping about 800 tons per day of run-of-mine coal. It is a matter of conjecture as to whether the Company intend to resume work in the old mine permanently, or only to draw off the loose coal that had accumulated during the process of mining.

The seam, 12 feet thick and lying at an angle of 82 degrees, had been developed by a pair of gangways or levels, 9 feet high and 12 feet wide, driven in the seam and spaced 30 feet apart, one above the other, with holings at intervals of 60 feet. Vertical chutes, 5 feet by 5 feet, are driven from the upper gangway to the rise, at intervals of 25 feet, and at a height of 30 feet, a breast, 175 feet wide, is driven to the rise, containing seven room-chutes, 5 feet by 5 feet, lined with timber, 3 inches thick and 12 inches wide. A travelling-way, 4 feet by 4 feet, is driven on the hanging-wall, at each side of each breast of work. A rib of coal, about 34 feet wide, is left between the breasts, and the manway, 4 feet by 4 feet, is driven in the middle. The only coal, up to the present time, shipped from the breasts is that due to the increase in the bulk of loose coal over that of solid coal *in situ*, and represents about 33 per cent. of the coal mined in the breasts (Fig. 1, Plate IV.). The mine is ventilated by a forcing fan placed on the inlet-gangway, and the air leaves the mine by the return level.

Mr. Alexander Faulds (Vancouver Island, British Columbia) wrote that had this disaster, which happened about 4·15 a.m., occurred in the day instead of at night, the loss of life would have been much greater, as a considerable force of men would have been engaged in and about the mine-mouth, erecting buildings and a new tipple, and installing an electric-light plant, all of which were completely destroyed.

The valley, about 1 mile wide, lies between Turtle Mountain and the foot-hills of a rocky range of mountains to the north. The Old-man river flows through the valley (Fig. 2, Plate IV.), close to the foot of Turtle Mountain, and the mountain-wall is so high (Fig. 1, Plate IV.) that on the longest day in summer the sun sets in the town at 3 p.m.

To illustrate Discussion on "The Rock-slide at Frank" etc.

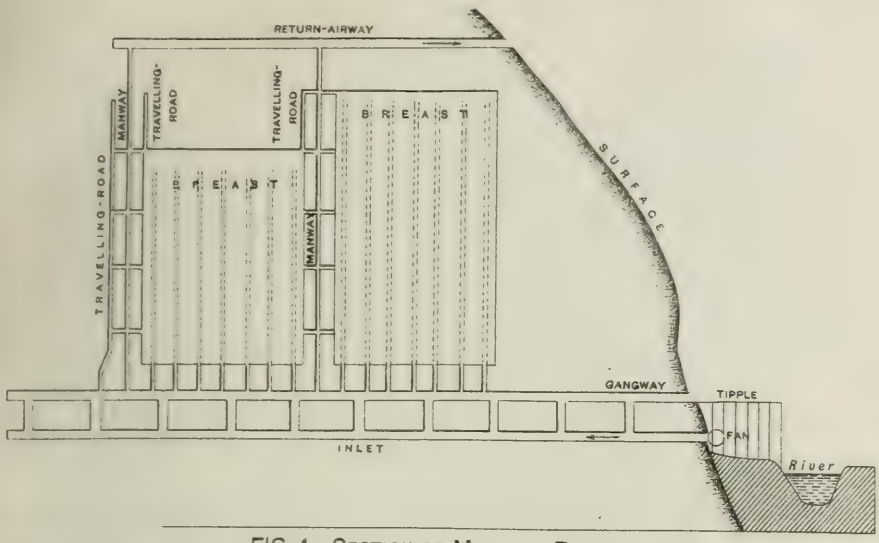


FIG. 1.—Section of Mines at Frank.

Scale, 200 Feet to 1 Inch.

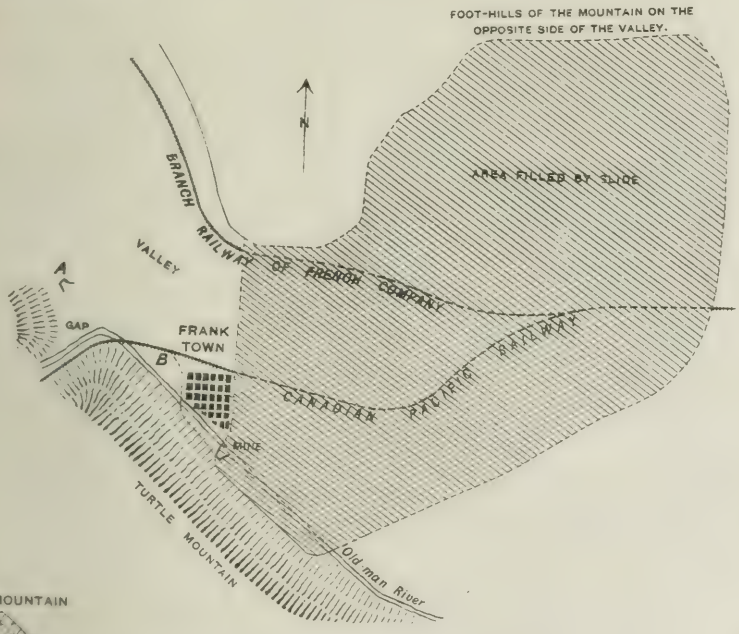


FIG. 2.—Map of Region about Frank.

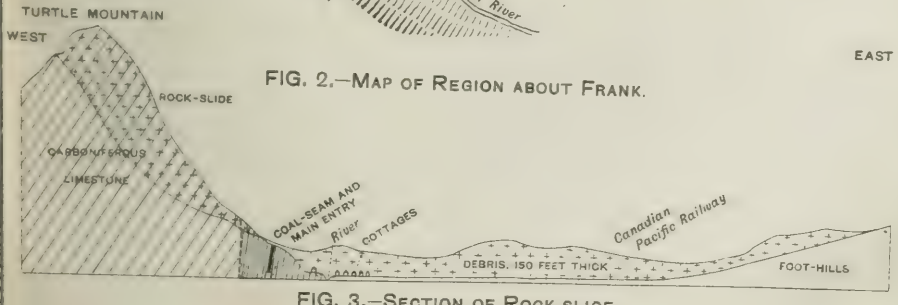


FIG. 3.—Section of Rock-slide.

The coal-mine extends along the side of Turtle Mountain in a parallel direction. The mountain fell away immediately over the workings, burying the entrance to a depth of more than 100 feet. Part of the debris of the mountain crossed the valley to the foot-hills on the opposite side, converting cosy homes and valuable property into a waste. Between the two peaks of Turtle Mountain, a huge semi-circle had been gouged out, extending downward from the top almost to the foot.

In the early morning, a great cloud which changed to a deluge of rocks, mud and debris poured down the rugged slopes of the mountain, damming to a depth of 40 or 50 feet the Old-man river, and the water passed into the gangway of the mine, flooding it for several feet in height.

The mine was situated directly in the path of the slide; and the section (Fig. 1, Plate IV.) gives an idea of the mode of working and the contour of the mountain at this point.

Two miles of the Canadian Pacific railway were buried under many feet of rock, necessitating the locating and building of another line.

Mr. Daniel M. McKenzie, one of the entombed miners, stated that the top of his place moved in bodily from 1½ to 2 feet. There was indication of a squeeze, chute and entry-timbers being badly broken, but there was not any serious damage done in the mine beyond the first 100 feet at the entrance. The imprisoned miners dug 30 feet across and 9 feet upward in soft material to their liberty, while rescuers, from the outside, also worked towards the imprisoned men. Fortunately, just above the mine-mouth there was a bare perpendicular face of rock about 50 feet high; this had not come down with the slide, and the chute, which it formed by its curve, threw the rocks outward some distance beyond the entrance to the mine. Only a little of the debris which came down in the first great rush, killing a driver and a trapper at the tunnel-mouth, fell over the mine-opening.

Mr. A. J. Hill (New Westminster, British Columbia) wrote that no one, acquainted with the geology and surface-characteristics obtaining throughout the mountainous regions of British Columbia, was deceived by the first sensational reports of volcanic outbursts or gas-explosions as the moving cause of

the catastrophe. The frequent occurrence of similar rock-slides everywhere along these great canyons both in modern and prehistoric times, was sufficient evidence that the startling news from Frank indicated but one more added to the list. Sections across the canyons show intermittent rocky precipices from several hundreds to some thousands of feet in height, composed generally of highly metamorphosed material, deeply fissured and shivered into incoherent fragments, waiting only for a season of extra precipitation and the resulting tremendous bursting force of crevices surcharged to an unusual level, to precipitate the cataclysm and hurl the whole disintegrated mountain-face into the valley below.

He (Mr. Hill) was a witness of one gigantic slide, in this case of earth (but no doubt due to like causes) which brought down some hundreds of acres of cultivated fields, forcing the mass, with ½ mile of frontage across the Thompson river (a rapid stream 500 feet in width and of ample volume), and holding it in complete check for 42 hours and to a height of 120 feet, and flooding the lower lands up-stream for 10 miles. The Grand rock-slide, 90 miles above Yale, which closely approaches that at Frank in magnitude is a case in point, dating from prehistoric times for the greater portion of its volume; but it continues to send down an occasional boulder as evidence of the forces still unexhausted.

To the disintegration of the rock generally and the creation of a head of water of great bursting power behind the shattered masses, may probably be attributed the ultimate cause of nearly all these slides, whether of earth or rock, and, as long as these great canyons exist, the mountain-regions can never be free from such slides.

Mr. G. F. Monckton (Copper-creek Mines, Savonas, British Columbia) wrote that this catastrophe was undoubtedly due to the removal of the coal-seam which formed a natural support to the foot of the mountain. The seam had been practically all worked out for a length of over 3,000 feet, up to a height of 300 feet above the level of the floor of the valley. Some of it was still stored in the workings. Pillars, 20 feet wide, were left between the rooms. The output averaged 600 tons daily, and had attained 1,000 tons. As the Carboniferous Limestone,

which towered over the coal-seam, and formed Turtle Mountain, dipped at an angle of 40 degrees into the hill, it was only a question of time when nature would take steps to fill the vacuum thus created. It must be noticed that there had been a squeeze in the mine, masses of rock had become detached from the wall nearest the mountain, and had fallen into the workings some time previously. After the first fissures had opened on the mountain, due to the movement of its face, which sloped in some places at an angle of 60 degrees, ice would collect in them and exert great pressure to accelerate the movement, especially in the spring when it would be alternately thawing and freezing. Without going into deep calculations, the mere fact that water expands 9 per cent. in freezing will show this, and those who have travelled among high mountains in spring will have had sufficient experience of the effects. It would seem impossible to work this mine with safety unless a system of filling were adopted; and this might perhaps be feasible, as the material could be taken from ground above the outcrop.

DISCUSSION OF MR. W. E. WALKER'S PAPER ON THE "HÆMATITE-DEPOSITS AND HÆMATITE-MINING IN WEST CUMBERLAND."*

Mr. H. D. Hoskold (Buenos Aires) wrote that, in his opinion, the subject of iron-ore deposits, some of which had partly been noticed in the paper of Mr. W. E. Walker, was exceedingly interesting and important, and if other members with sufficient leisure were to follow with other papers upon all the more important iron-ore districts of Great Britain, going more into detail as to productive qualities, cost of development, probable profit to be derived and duration, great service would be rendered to the iron-smelting industry and others depending thereon.

The majority of rich hæmatite-mines of the Forest of Dean, had, for want of sufficient capital to sink to greater depths, been abandoned; but not before it was proved that on the eastern side of the basin, the deposits of hæmatite, over a distance of 3 miles in length, or more, were as extensive and rich in the deep workings as they had been near the surface. Doubtless, the abandonment was due to the scarcity of ore-deposits and the high cost of extract-

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 292.

ing the mineral from deep workings, and other mining districts would, in the near future, have to be abandoned for a like reason. It would, therefore, seem to be necessary to make further explorations in promising districts, for, at present, it would appear that the time is fast approaching when iron-smelters will have to depend for their supplies of iron-ore upon foreign countries. Mr. Walker seemed to make it clear that the best days of Bilbao hæmatite-mining had passed, and it was highly probable that other similar deposits do not exist in any accessible place in Spain or probably, in any other country under such favourable conditions as would leave a sufficient margin of profit to the British smelter. Nothing could prove so injurious to the general prosperity, stability, commercial relations, and domination of the British Empire, as a continued decline in the iron- and steel-trade, and coal-production. Consequently, it is absolutely necessary that some stringent economic and legislative means should be adopted to preserve the resources of the coal-fields beyond the 300 years estimated period of duration, in order to maintain home-manufactures, commerce, and British supremacy.

Referring to the Cumberland iron-ore district, when the mineral occurred near to the surface, the yield was greater, and the extraction less costly than when extracted from greater depths. According to Mr. Walker's showing, two of the four deposits he enumerated, that was, the upper ones, were represented to be nearly exhausted: but he estimated that the two lower deposits of hæmatite "extend over a considerable area" and may consequently yield a large quantity of hæmatite. He also stated that "the No. 4 bed is found lying on the slate-rock or on a calcareous limestone."* This remark would seem to indicate the presence of the Silurian formation and the absence of Devonian rocks.

Prof. John Arthur Phillips stated that "the red hæmatite from the vicinity of Whitehaven in Cumberland, and of Furness in Lancashire, is obtained either from Carboniferous rocks or from those of Silurian age. Practically, however, it is almost entirely derived from the former, since the deposits in the Silurian rocks are of extremely limited extent. The Carboniferous Limestone series, in which the principal deposits occur in both districts, consist mainly, as before stated, of alterna-

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 295.

tions of limestones, with shales and sandstones."* The facts of borings having been made, and that pits were in course of sinking down to 1,200 feet in depth, would seem to indicate that newer discoveries have been made in the lower series of the hæmatite-deposits.

Mr. Walker referred to the big winding-engines and pumping machinery employed at pits of less depth; but nothing was said with reference to the class and cost of the machinery required at the deeper workings, nor of the amount of water expected, nor of the extra cost per ton of mineral raised. It was to be regretted that such omissions had been made in the paper, because a scale of cost for plant and for the extraction of the hæmatite from shallow and deeper workings would show approximately their comparative value, and how far the deeper explorations could in all probability be profitably carried on, as also, the time estimated when the Cumberland iron-ore districts would cease to be worked.

The remarks of Mr. J. D. Kendall upon Mr. Walker's paper, did not encourage the hope that the best days of Cumberland hæmatite-mining were yet to come: on the contrary, he seemed to prove that the produce of the mines was on the decline, at the rate of about 50 per cent. in the space of 20 years, so that according to this estimate, and in the absence of other important discoveries of hæmatite, mining in the vicinity of Whitehaven, that is, the hæmatite-district, would most likely be closed in less than 20 years.

Many years since, he (Mr. Hoskold) had the inspection of hæmatite-mines situated at Lamplugh; but, previously, the greater part of the iron-ore had been extracted. The machinery and pits were in a deplorable condition, and after some explorations had been made and a small quantity of hæmatite extracted, he declined to continue his periodical inspections. A particular examination of the journal of the borings which had been made upon the Lamplugh mining estate proved that no important deposits of iron-ore had been struck, sufficient to warrant the expenditure necessary for erecting new machinery and sinking other pits. The journal in question did not indicate that the borings had been carried deeper than the upper limestone-beds, in which it is generally believed that the

* *A Treatise on Ore-deposits*, 1884, page 160.

most important deposits of hæmatite occur. If the lower deposit referred to as No. 4 bed by Mr. Walker, and as resting upon the Silurian rocks, exists under the Lamplugh estate, further borings would have to be made to prove its extent and value.

Mineral-veins occur in various rock-formations, and the study connected therewith is very important; but it would be out of place in a discussion of this class to go over the various theories propounded in standard works upon the subject. Occasionally, however, opinions are emitted which do not appear to fit in with all the circumstances and conditions so frequently presented to the engineer for solution. It was difficult to believe that the hæmatite-deposits found in the Carboniferous Limestone in various parts of England were not formed in the same or a similar manner. Upon this point Mr. Cedric Vaughan said: "If, as Mr. Kendall suggests, this salt of iron came from below in a gaseous condition through the then recently-formed faults in the Carboniferous Limestone, and coming into contact with water formed a solution of perchloride of iron, then, as he has shown, the whole of the facts become simple and easily understood by the chemical formula which he gives."* A good deal was intimated in the passage quoted; but very little proved. And we must remember that in a chemical laboratory it is easy to produce any such reaction as may be desired to assist in the formation of a theory: though similar reactions in nature's laboratory are more difficult to be understood, because the restrictive principles in each case are different, and he (Mr. Hoskold) thought that the theory proposed and referred to by Mr. Vaughan, did not fit in with all the circumstances and conditions under which all hæmatite-deposits occur.

Referring to that well-known and extensive hæmatite producing district, in the past, that was, the Forest of Dean, for some curious evidence, he might state that on the eastern side of that mineral basin, it had been proved that for a distance of about 5½ miles along the outcrops of the iron-ore, or from the Howbeach valley southward to the Westbury brook iron-mine, northward, near to Mitcheldean, no evidence exists that the limestone-measures have been disturbed by faults, and, therefore, the assertion of Mr. Walker "that if there were

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 298.

no faults, there would be no hæmatite-ore, because there would have been no spaces in which iron-ore could have been deposited "* is not correct in this case. In the district just referred to, a large number of exceedingly extensive deposits of hæmatite occurred, separated one from the other by solid bars of rock of considerable length. These deposits of iron-ore rest upon a bed of fine-grained crystalline limestone, locally called the "Underedge." Each of these deposits generally has a thickness of 30 to 40 feet, that is, extending laterally from the Underedge limestone to the contact with another well-marked bed of limestone, called the "Lid," or cover of the iron-ore measures. In a word, generally speaking, no iron-ore of importance occurs below the Underedge limestone or above the Lid limestone. The dip of the Underedge is from 70 to 75 degrees, and its strike about south 35 degrees west, and north 35 degrees east. When each deposit of hæmatite has been extracted from the exploring heading or water-level upwards or to the rise, to meet other older workings, an immense cave is left in each case, having a rugged water-worn appearance. Many of these caves exist at the surface and extend downwards at the rate of dip named, for a great distance, or to the lowest exploring heading that has been made. The deposits of iron-ore are not situated one above another vertically in the limestone, as generally seems to be the case in the hæmatite-mines of Cumberland; but upon the same zone, or Underedge limestone, and, as previously noticed, they occur in succession as the exploring tunnel or level-heading advances in the direction of the strike of the Underedge limestone, and upon it. The dip of the hæmatite-deposits is generally at right angles to the strike. Upon rare occasions, a few of the deposits of iron-ore have been known to terminate in the deeper workings, and when this is the case the lower part of the Underedge limestone gradually rises from its usual amount of dip until it is in contact with the Lid Limestone. The termination of the cave downwards presents the form of the thin edge of a wedge. The reverse of this has been known to occur, that is, at the deepest exploring heading in one of the mines, a deposit of hæmatite occurred upon the Underedge limestone, and extending along the strike of it for 900 feet, filling the entire measures, or 40 feet in thickness. But it is

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 296.

very curious to observe that this deposit of iron-ore extended only a few feet upwards upon the rise or above the water-level. It was, therefore, a new deposit extending under the water-level, but to what depth is unknown. There were no indications at the surface-outcroppings that this deposit existed in depth. The iron-ore measures, or bed of rock containing the great deposits, and existing between the Underedge limestone and the Lid limestone, is of a reddish colour, and is a coarse-grained limestone, locally called "Crease," and totally different from all the other beds of limestone. It is this particular bed of rock which, according to the theory (noted by Mr. C. Vaughan), must have been removed or displaced in certain places by some local influence, and so formed depressions or caverns in it in various confined localities before the hæmatite was deposited. It is very curious to note that such depressions or caverns are sometimes filled with indurated brown mud or clay, instead of iron-ore. Here, again, it should be noted that Mr. Walker's expression "because there would have been no spaces in which iron-ore could have been deposited" is not supported by facts. In the whole district referred to there is no evidence that gaseous emanations came from below, and combining with water produced the action referred to by Mr. C. Vaughan. If the Crease limestone was originally displaced by some dissolving or corrosive solution, such as that suggested, and so formed the depressions or caves noticed, some other agent or special conditions must have been present at the same time to confine the dissolving solution to certain particular places or limited areas, that is, the hollows in which the hæmatite was deposited. Otherwise it is natural to suppose that if the corrosive solution had existed in quantity and been continuous, the entire area of the Crease limestone must have been exposed to its influence and must have been affected: that is, the adjacent parts of the limestone surrounding the excavated parts or hollows, being of the same nature, would also have been liable to displacement. It has never been discussed whether the hollows in the Crease limestone were made and filled with hæmatite-ore before the Lid limestone was deposited, or afterwards; or before, or after, the Limestone-measures were tilted to form a dip of 70 degrees.

If the theory of Mr. Kendall, and apparently endorsed by Mr Vaughan, were true, it would seem to be anomalous that

when the Crease limestone had been displaced, the hollows so formed were filled with clay instead of iron-ore. This particular circumstance does not favour the idea enunciated by Mr. Walker that "there would have been no spaces in which iron-ore could have been deposited:" nor the theory of Mr. Kendall as to the particular mode or cause of the deposits of iron-ore in the Carboniferous Limestone.

However, the same conditions in the same district do not always exist, as he (Mr. Hoskold) would now endeavour to show. On the western side of the Forest of Dean mineral-basin, previously referred to, and at a distance of about 1½ miles from the town of Coleford, in a south-westerly direction, many excavations have been made in the Carboniferous Limestone, presumably by Roman miners, and to a considerable depth. Evidence is presented to-day that these old miners extracted large quantities of iron-ore, and they frequently holed into natural caves of immense size also presenting a rugged water-worn appearance. By penetrating into the old Roman workings, these natural caves, which are numerous, may still be inspected. There is no appearance that iron-ore ever occurred in these caves; but it was sufficiently abundant to the rise and to the dip of them. If these natural caves had been formed upon the principle advanced in the theory of Mr. Kendall, they should have been filled with iron-ore, and extracted, as in other cases, by the Romans. It is, however, known that these natural caves are connected to a lower drainage level, and this has been urged as a reason why the natural caves were not filled with iron-ore. He (Mr. Hoskold) had seen similar phenomena in the limestone-mountains in the province of Santander, Spain. In the blende and calamine mining-districts there, natural caves of immense size are found in which, from the stalactitic appearances, zinc-mineral could never have occurred.

Considering all the difficulties connected with the origin of the materials which formed hæmatite-ore, and the particular manner of its deposition, he (Mr. Hoskold) was not prepared to accept the theory referred to by Mr. Vaughan.

Mr. J. D. Kendall (London) wrote that Mr. Hoskold was clearly not acquainted with the district under discussion nor with the principal features of its ore-deposits. The substitu-

tional origin of the West Cumberland deposits was, as he (Mr. Kendall) had elsewhere shown, a geological necessity and was quite independent of the particular chemical process by which it was carried out. The caverns existing in the district are much more recent than the ore-deposits and their presence does not affect his (Mr. Kendall's) explanation in any way. They had been formed by simple removal of limestone, and not by a substitution of hæmatite for that mineral.

Mr. W. E. Walker (Whitehaven), with regard to those deposits which, owing to their being to the dip, are found at a great depth, wrote that much larger capital is necessarily required for the sinking and providing of plant than was the case, many years ago, when sinking to Nos. 1, 2 and 3 beds, which were found at, comparatively speaking, shallow depths: although on the eastern side of the West Cumberland hæmatite-field, the No. 4 bed, at places, is within a few feet of the surface and immediately underlying the gravel, and, proceeding westward, the ore dips under the Carboniferous Limestone, generally at an angle of from 7 to 12 inches per yard.

The capital required for the sinking of deep shafts varies considerably according to circumstances, and that is why he (Mr. Walker) stated in his paper that "£10,000, £20,000 and even £30,000, do not always cover it now." There is no scale of cost for plant nor for the extraction of the hæmatite nor could there be, because of the different conditions under which the hæmatite is found, nor is there any particular class of engine for either winding or pumping. Some of the winding-engines are ordinary double horizontal and some compound, while some of the pumping-engines are horizontal condensing, some compound and others grasshopper. Much depends on the particular fancy of the lessees or their representatives, although in many cases second-hand winding-engines and pumping-engines, practically as good as new, have been bought for a trifle, as compared with the original cost, and when and where such can be purchased, they generally are bought irrespective of the particular type. Electrical haulage, as well as pumping, is now being introduced at some of the West Cumberland hæmatite-mines.

The amount of water, expected to be met with, varies according to circumstances. The area of the water-shed, rainfall, etc.,

must be considered. If there are neighbouring lessees to the dip, they may, in the natural course of things, drain the water from your mine; or it may be that your mine lies to the dip of your neighbour's, and, if so, it may be that you drain the water from their mine. It may be taken in a general way that the water does not exceed 10,000 to 15,000 gallons per hour, except in cases where the mine-workings are near to or under a river and where the surface has, through mining operations, become damaged, or in case of a river overflowing its banks during extra heavy rains, but this very seldom happens. He (Mr. Walker) had known of mines where over 40,000 gallons per hour had been pumped at one shaft for over a week at a time, but these are exceptional cases, yet, of course, where expected, pumping arrangements must be provided accordingly.

After securing a royalty, bore-holes are put down, and then, if ore is found, a site is fixed for the shaft, and the estimates are made of the cost of sinking, providing of plant, railway connections, etc.

As a rule, lessees do not pay so high a tonnage or royalty rent for hæmatite lying at a great depth as if it were at a shallow depth, and the difference is considered to stand in towards recouping the lessee for his extra expenditure of capital. There is no fixed dead, tonnage or royalty-rent scale in West Cumberland for hæmatite, the royalty is leased on the best obtainable terms and conditions, including a dead-rent, merging into a minimum tonnage or royalty-rent, with a sliding scale, according to the selling price or selling value of the ore, and these terms vary considerably, according to the geographical and geological positions respectively of the royalty.

It was true that the output of hæmatite in West Cumberland had decreased during the past 20 years but new and important ore-fields had recently been found and were being opened in the Egremont district of Cumberland, and it was more than probable that the output of the next 20 years would far exceed the output of years gone by.

There are several instances in West Cumberland where spaces are found in Carboniferous Limestone in hæmatite-mines, which the hæmatite, to use a miner's phrase, has missed; and all these spaces, when cut into, either contain water or show clearly, by their waterworn appearance, that water, at some period, passed

through them. Although he (Mr. Walker) considered that it had no bearing on this question, he might state that he had occasionally, though not frequently, found huge caverns in the hæmatite, with absolutely nothing but hæmatite all round: possibly "heat" may have played an important part in the formation of these caverns.

Hæmatite-mines in West Cumberland have been worked on a considerable scale for over 50 years, at various points, and for a distance of about 8 to 9 miles in length. The length of hæmatite-bearing ground, partly proved and to be proved, at and to the south of Egremont, is about 8 to 9 miles and that to the north of Lamplugh, about 7 miles. There are several areas within the first 8 to 9 miles still entirely unproved, although several explorations are now being carried out, some of which had, so far, been successful. Consequently, the hæmatite-bearing ground in West Cumberland has a possibility of holding out, at a reasonable rate of output, for the next generation, and he (Mr. Walker) might add that practically the same remarks as to unproved iron-ore-bearing ground, as well as to the hæmatite-deposits at deeper levels than those hitherto worked, apply equally to the Furness district of North Lancashire.

He (Mr. Walker) had never visited the mines in the Forest of Dean, but he suggested it was probable that the "solid bars of rock of considerable length" mentioned by Mr. Hoskold, might be faults; and that some spaces, formerly underground water-courses, became filled with hæmatite, while other spaces were missed. There are well defined faults and empty spaces in the Furness district of North Lancashire as well as in West Cumberland. Further he (Mr. Walker) might add that at Brixham, in Devonshire, where iron-ore was formerly worked for several years, there is one very large and well-defined exposed fault; and at Avoca, in Ireland, where a large quantity of iron-ore (containing about 6 per cent. of phosphorus) was worked opencast, well-defined faults can be seen. He understood, when visiting both Brixham and Avoca, several years ago, that mining was not being continued on account of litigation at both places: and he anticipated that, some day, both of these districts will again become important iron-ore mining districts.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING,
HELD IN THE WOOD MEMORIAL HALL, NEWCASTLE-UPON-TYNE,
DECEMBER 12TH, 1903.

MR. W. O. WOOD, PRESIDENT, IN THE CHAIR.

DEATH OF MR. WILLIAM COCHRANE.

The PRESIDENT (Mr. W. O. Wood) referred in sympathetic terms to the death of Mr William Cochrane, who for many years had occupied a very honourable position in the Institute. He became a member in August, 1861; was Vice-President from 1870-1882 and 1884-1890; and President from 1890-1891. Mr. Cochrane had rendered great assistance to the Institute, and, at all times, took keen interest in its affairs. He (Mr. W. O. Wood) moved that a letter of condolence be addressed to the family of the late Mr. William Cochrane, expressing the great regret of the members at his death, and conveying their sympathy with them in their bereavement.

Mr. J. H. MERIVALE seconded the proposal, which was unanimously adopted.

The SECRETARY read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on November 28th and that day.

The following gentlemen were elected, having been previously nominated:—

MEMBERS—

MR. WILLIAM RALPH BELL, Colliery Under-manager, Wearmouth Colliery, Sunderland.

MR. PERCY O. BONNIWELL, Chief Engineer, Engineering Insurance Department, Law Accident Insurance Society, Limited, 215, Strand, London W.C.

Mr. Charles Brent, Mining Engineer and Metallurgist, Rat Portage, Ontario, Canada.

Mr. Bourn Russell Chicken, Mechanical Engineer, 42, Sunbury Avenue, Jesmond, Newcastle-upon-Tyne.

Mr. Arthur Edwin Dixon, Geologist and Mine-manager, Hampson's Collieries, Waschbank, Natal, South Africa.

Mr. Charles Manning Donohoe, Mining Engineer, 28, Johnson Street, Lynn, Massachusetts, United States of America.

Mr. William Draper, Colliery Manager, Silksworth Colliery, Sunderland.

Mr. James M. Gummerson, Engineer, 35, Birkbeck Road, Acton, London, W.

Mr. Arthur Morton Hedley, Mining Engineer, Blaydon Burn, Blaydon-upon-Tyne.

Mr. John Hogg, Mechanical Engineer, Thornley Colliery Office, Thornley, R.S.O., County Durham.

Mr. Christopher Hunter, Mechanical Engineer, Cowpen Colliery Office, Blyth, Northumberland.

Mr. Frederick Ernest Jacob, Mining Engineer, Westbrook, Swansea.

Mr. James Johnson, Sinking and Boring Contractor, Boldon Lodge, East Boldon, *via* Newcastle-upon-Tyne.

Mr. Frank Little, Electric-power Engineer, Ward's Buildings, High Bridge, Newcastle-upon-Tyne.

Mr. Benjamin Francis McDowell, Mining Engineer, P.O. Box 10, Macequece, Portuguese East Africa.

Mr. James Heppell Marr, Mining Engineer, Malton Colliery, near Durham.

Mr. Herbert William Middleton, Colliery Manager, Trimdon Colliery, R.S.O., County Durham.

Mr. Frank Percy, Engineering Lecturer and Consulting Engineer, Mining College, Wigan, Lancashire.

Mr. John Robinson, Colliery Manager, Longhirst Hall Colliery, near Morpeth, Northumberland.

Mr. John Scorer, Mechanical Engineer, Barakar, E.I. Railway, Bengal, India.

Mr. Ralph Storey Swallow, Colliery Manager, The Garth, Medomsley, R.S.O., County Durham.

Mr. John Fox Tallis, Mining and Civil Engineer, The Firs, Ebbw Vale, Monmouthshire.

Mr. John Thomas Tennant, Inspector of Collieries, James Street, Hamilton, Newcastle, New South Wales.

Mr. Joseph Thompson, Colliery Manager, North Biddick Colliery, Washington Station, County Durham.

Mr. James Tinsley, Colliery Manager, Bridge House, Ebbw Vale, Monmouthshire.

Mr. Robert G. Ware, Superintendent, Vinton Colliery Company, Vintondale, Pennsylvania, United States of America.

Mr. Robert Gott Wilson, Colliery Manager, Whitehill Terrace, Pelton Colliery, Chester-le-Street, County Durham.

Associates—

Mr. Henry Armstrong, Overman, 41, Church Street, Murton Colliery, *via* Sunderland.

Mr. George Arthur Hawes, Deputy and Science Teacher, 34, New Pilgrim Street, Murton Colliery, *via* Sunderland.

Mr. William Oliver, Deputy-overman, 14, Model Street, New Seaham, *via* Sunderland.

Mr. Thomas Schollick, Back-overman, 21, Hall Street, New Seaham, *via* Sunderland.

Mr. Maurice Hewson Wilkinson, Overman, Medomsley, R.S.O., County Durham.

Students—

Mr. Thomas Blandford, Mining Student, Deaf Hill Colliery, Trimdon Grange, R.S.O., County Durham.

Mr. George Harold Greenwell, Mining Student, 4, Ivy Avenue, Ryton-upon-Tyne.

Mr. Andrew Kirkwood McCosh, Jun., Mining Student, Coundon, Bishop Auckland.

Mr. Robert A. Purvis, Mining Apprentice, Inglethorpe, Harton, South Shields.

Subscriber—

Messrs. A. Goerz & Company, Limited, 20, Bishopsgate Street Within, London, E.C.

DEATH OF MR. A. L. COLLINS.*

The following letters were read:—

Newcastle-upon-Tyne,
July 9th, 1903.

Sir,

With further reference to my letter of February 7th, and your reply thereto of April 21st, 1903, I enclose herewith extract from the issue of the *Engineering and Mining Journal* (New York) of June 27th last referring to the murder of Mr. Arthur L. Collins at Telluride in November last. †

The Council trust that the British Ambassador to the United States may be instructed to use every endeavour in order that the perpetrators of this murder may be brought to an early trial.

I have the honour to be, Sir,
Your obedient Servant,
M. Walton Brown,
Secretary.

The Right Honourable the Secretary of State,
Foreign Office, London, S.W.

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* *Trans. Inst. M.E.*, 1903, vol. xxv., page 288.

† Telluride Again.—After the assassination of Arthur L. Collins, last November, a spirit of opposition to disorder and lawlessness caused the citizens of Telluride, Colorado, to demand legal action. A grand jury was called, and a number of men were indicted as having been privy to the murders and riotous assaults, which have disfigured the record of a splendid mining district. Now comes the sequel. When court met recently, the sapient judge announced that he had called the grand jury last December in an irregular manner. All the indictments were quashed. This happened late on a Saturday night. On the Sunday following it was understood that the *District-attorney* was preparing new indictments. A tremendous snowstorm, terrible even for that mountainous

FOREIGN OFFICE,
October 22nd, 1903.

SIR,

With reference to the letter from this office of the 17th of July last, I am directed by the Marquess of Lansdowne to transmit to you a copy of a letter, which has been received through His Majesty's Embassy at Washington, addressed by the *District-attorney* of Colorado to the Governor of that State, and giving an account of the efforts which have been made to trace the persons guilty of the murder of Mr. A. L. Collins at Telluride.

From this letter you will see that the efforts of the local authorities to discover the guilty parties have so far been unsuccessful. Lord Lansdowne gathers, however, from the last sentence that those efforts will not be relaxed, and on the receipt of any later information on the subject a further communication will be addressed to you.

I am, Sir,
Your most obedient humble Servant,
CHARLES HARDINGE.

The Secretary to the North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne.

September 26th, 1903.

SIR,

Further answering your respected favour of September 8th, 1903, concerning the assassination of Mr. Arthur Lancelot Collins at Telluride, Colorado, I beg herewith to quote statement made to me under date of September 21st, 1903, by Mr. Edward C. Howe, my deputy district-attorney at Telluride, Colorado, for San Miguel County, as follows:—

"Replying to your favour of September 14th, in which you ask what efforts have been made to ascertain the identity of the murderer of Arthur L. Collins, I have to say that I believe every reasonable effort that could be made has been made, and that everything that could be done has been done. The State offered a reward of 2,000 dollars, and the County offered a reward of 10,000 dollars, for information leading to the arrest and conviction of the murderer. Numerous rumours and clues have been furnished to me from various sources; some seeming very mythical, and others appearing to have some foundation. Each of them, however, has been investigated, whether the same seemed to merit investigation or not. I have in person made trips to Durango, Rico, Ouray and other places in connection with these matters. We sent one man clear to Southern Arizona in connection with it. Also private investigations have been made, but so far nothing has been accomplished towards identifying any particular party with it.

region, came on: and in the teeth of it, those who had been indicted fled across country, catching the train at various points and so escaping.

Such happenings as this make a fool of the law and constitute an impertinence to justice. So long as criminals can get the best legal talent arrayed on their side, while the law of the land is administered and upheld by men competent only for political office and for positions which are the reward for political activity, so long will there be a premium on lawlessness in our mining regions.

There is only one remedy for this state of affairs, and that is enlightened public opinion. If the good men in the community are afraid to speak out, save when they feel an occasional spasm of civic virtue, then there is little likelihood of the development of a healthy reprobation of such methods. And this applies to larger communities, no less than to a mining settlement like Telluride.—*The Engineering and Mining Journal* [New York], June 27th, 1903.

The only evidence in connection with it, which has been found, was the finding of a repeating shot-gun, commonly known as a "pump-gun," which was found on the banks of Royer Creek this spring, after the snows melted, which contained two or three shells loaded with buck-shot, and of the same style and calibre as the shell found in the yard after Mr. Collins was shot; but further than this I have nothing to report, which can be considered as evidence in the matter at all."

I can add no further information to this statement. Your Excellency is well aware that The Smuggler Union Mine had its office at Pandora, some distance outside of the town of Telluride, at the time Mr. Collins was killed there, and was outside of police protection. There could not have been a better place for an assassination than that, because the chances of detection were few on account of the situation.

While the officers have suspicions as to who were the instigators of this killing, these suspicions have not been verified by any positive evidence to date and consequently it would not be proper to state what they are.

I beg to assure Your Excellency that the killing of Mr. Collins was universally condemned in that community, outside of the class which had antagonized him, and that the entire local government of San Miguel County has been keenly alive to the responsibilities imposed upon it by this situation, and no effort has been or will be relaxed by any officer to bring to justice the perpetrators of this assassination.

Yours very truly,

S. G. McMullin,

District-attorney.

His Excellency James H. Peabody,
Governor of Colorado,
Denver, Colorado.

DISCUSSION OF THE "REPORT OF THE COMMITTEE UPON MECHANICAL COAL-CUTTING."*

Mr. T. W. Benson (Newcastle-upon-Tyne) asked whether there was any advantage in using coal-cutting machines in long-wall working, in a seam varying from 28 inches to 30 inches in thickness, if hewers were getting by hand-holing from 3 to 3½ tons per day, at a tonnage-price of 1s. 3d. to 1s. 6d., and where the difference in selling price—between round and small coal—was say 2s. 6d. to 3s. per ton.

Mr. J. B. Atkinson (H.M. Inspector of Mines, Newcastle-upon-Tyne) mentioned that in the neighbourhood of Airdrie, in Scotland, the Lower Drumgray, a valuable seam of house-coal, 30 inches thick, had been for 10 or 15 years worked almost entirely by coal-cutting machinery, principally on account of the increased percentage of round coal obtained.

* *Trans. Inst. M.E.*, 1903, vol. xxvi., page 141.

Mr. T. E. Forster (Newcastle-upon-Tyne) said that all the conditions would have to be taken into account, and he was afraid the Committee could hardly invent a formula to ascertain the tons which would be produced from a given seam, but if Mr. Benson would give full particulars as to the physical conditions he would endeavour to answer the question.

DISCUSSION OF MR. A. A. ATKINSON'S PAPER ON "WORKING COAL UNDER THE RIVER HUNTER, ETC."*

Mr. R. H. Brown (Halifax, Nova Scotia) wrote that as he had had the management for many years of one of the collieries mentioned by Mr. Atkinson, a few particulars connected with the practice of undersea working thereat, may be of some interest to the members. The Old Sydney mines are situated on the eastern coast of the island of Cape Breton, Nova Scotia, and it was the first mine in America to begin the working of coal under the waters of the Atlantic Ocean. The General Mining Association, London, were the owners of this colliery, until it was sold some three years ago to the Nova Scotia Steel and Coal Company, the present proprietors.

The coal worked is known as the Sydney Main seam, it averages between 5½ feet and 6 feet in thickness of coal of the best quality, dips in a north-easterly direction towards, and under, the ocean at an inclination of 1 in 12, while the strike is north-west and parallel with the general direction of the shore-line (Fig. 1). The floor, under the coal, is a fire-clay, and the immediate roof is sometimes of sandstone, and in some districts of shale or till, which falls readily at times, and is difficult to support with timbering. The seam is remarkably exempt from faults or slips of the strata, and occasionally rolls, or depressions occur in the roof, reducing the thickness of the seam over small areas. In the dip-workings, a thin seam of coal, from 6 to 12 inches thick, occurs in the strata about 8 feet above the main seam. The Princess and winding-shaft is sunk near the sea-coast, and is 687 feet in depth. Very little inflammable gas is met in working; but, as a precaution, only locked safety-lamps have, for some years past, been used.

* *Trans. Inst. M.E.*, 1902, vol. xxiii., page 622.

The working of the coal, under the sea, was commenced in April, 1877, under a cover at the shore-line of 690 feet of solid measures, although a portion of the workings, driven to the rise, under Sydney Harbour, was operated under a cover of 500 feet or less. The method of working was bord-and-pillar: the levels and winning-places were driven 6½ feet wide: the rooms or bords were 17 feet wide, their course being parallel to that of the levels; and the cross-cuts, through the pillars, were driven 9 feet wide. The pillars were left 40 feet wide and 123 feet long.

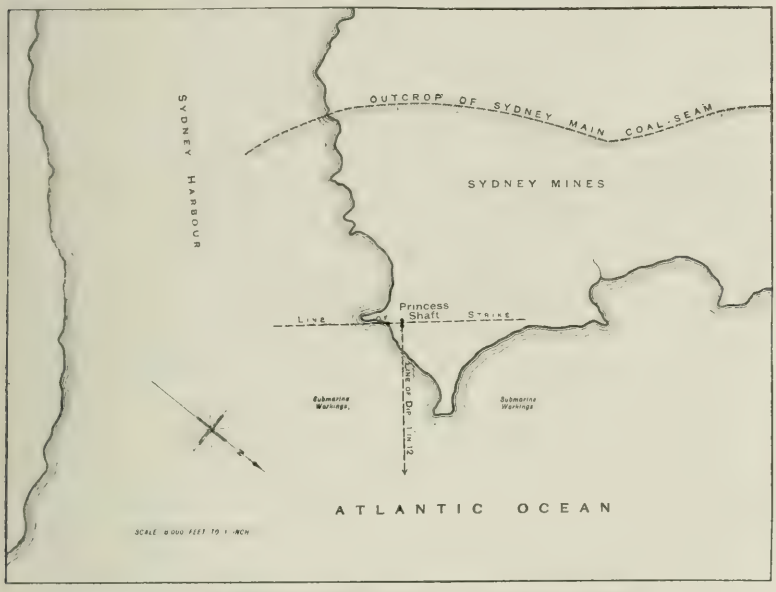

FIG. 1.—SKETCH-PLAN OF THE OLD SYDNEY MINES.
SCALE, 6,000 FEET TO 1 INCH.

The present faces of the workings have reached a distance from the shore-line of 5,800 feet to the dip. Here the overhead-cover is 1,140 feet thick of rock, with 33 feet depth of water above, this depth increasing to 37 feet at high tide. The levels, deeps and headways are now driven 8 feet wide; the bords are still 17 feet wide, and the cross-cuts, 9 to 12 feet wide. The pillars being left now are 66 feet wide and 148½ feet long.

The undersea workings in the whole coal at present cover an area of more than 1,620 acres, with an overhead cover averaging 900 feet of strata, and 18 feet of sea-water above.

For many years, the Company hesitated to begin the working of the pillars in this submarine lease, and contented themselves with

the intention of bringing back the pillars from the extreme faces, after the whole coal should have all been won. A very large area of pillars was thus left standing, and that, in some instances, for many years. However, it was eventually decided to commence working the pillars in a tentative way; and in January, 1899, a beginning was made by removing the pillars at two or three suitable points in the workings; and, at present, pillars are now being worked in six or seven districts of the mine. During September, 1899, the getting of coal by the longwall method was also inaugurated in a district of the mine, where there was a small area of low coal; the cover overhead here was about 1,000 feet thick.

Up to the present time, the pillars have been successfully removed from an area of 55 acres: almost all of the coal being got. Some 438,000 tons of pillar-coal have thus been taken; while from the 7 acres of whole coal, worked by longwall, some 46,000 tons of coal have been produced. Slight crushes, or creeps of the floor, were developed in two or three of the bord-and-pillar districts, but they were only local in effect. Where the roof comes down freely after the removal of the pillars, the falls do not seem to extend to a height of more than 10 or 12 feet above the seam, and the falling strata generally include the thin seam of coal already mentioned.

No sea-water has found its way into the workings as a result of the working of the pillars. Some workings driven to the rise in the whole coal-working produced a feeder of a few gallons of water per minute: this had evidently followed the seam of coal downward from a point where it cropped out under the waters of the harbour. No water has been known to come from overhead across the measures, and this immunity from leaks is probably due to the presence in the overhead strata of twelve beds of under-clay, or fire-clay, of an aggregate thickness of 36 feet 10 inches, as well as to the numerous beds of shale of more or less softness, which occur throughout (Table I.).

The subsidence due to the removal of a bed of coal, 6 feet thick, would probably, under these conditions, soon choke itself, so that there would be no actual settling or motion of the strata for more than 100 feet above the seam; and above that point the elasticity of the beds, already mentioned, would prevent any rupture. The condition of the immediate sea-bottom need

not be taken into consideration, at least in his experience, nor did the presence of a bed of clay thereon seem necessary to prevent the influx of water. The sea-bottom is rock, over the workings at the Old Sydney mines. The sandstones do not afford any protection, and a reference to the accompanying section of the strata passed through in sinking the Princess shaft (Table I.) shews that the 33 feet of sandstone encountered at a depth of 270 feet below the surface, and about 220 feet below sea-level, contained cracks and cutters, which allowed an influx of 650 gallons of sea-water per minute, into the shaft. This feeder probably followed the sandstone from its outcrop some 1,300 feet away under the water of Sydney Harbour. It was overcome, by tubbing the shafts from the surface downward for 300 feet.

TABLE I.—SECTION OF STRATA SUNK THROUGH IN THE PRINCESS PITS, OLD SYDNEY MINES, CAPE BRETON, NOVA SCOTIA.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Soil, sandstones and shales ...	81	3	81	3
	Lloyds Cove Seam.				
2	**COAL**, with 6 inches of clay-band	6	8	87	11
3	Sandstones and shales	172	5	260	4
4	**COAL**	0	3	260	7
5	Under-clay and shales	9	6	270	1
6	Sandstone, hard, with cracks and cutters, salt-water feeder, 650 gallons per minute	33	0	303	1
7	**COAL** ...	0	9	303	10
8	Under-clay, soft	1	10	305	8
9	**COAL**	0	8	306	4
10	Under-clay, strong	5	0	311	4
11	Shale, mixed with *coal*	1	3	312	7
12	Clay, soft	0	4	312	11
13	Shale, with *coal* at bottom	1	10	314	9
14	**COAL**	0	9	315	6
15	Under-clay and shale ...	1	10	317	4
16	Sandstone, strong, dark grey ...	10	8	328	0
17	Shale, soft, dark	3	2	331	2
18	**COAL** and shale mixed	0	10	332	0
19	Under-clay ...	3	0	335	0
20	Sandstone, slaty, with ironstone-nodules. — *Lepidodendron* and ferns in the partings...	16	9	351	9
21	Shale, hard blue, with irons one. —*Sigillaria* and ferns	4	0	355	9
22	**COAL**	1	2	356	11
23	Clay and black shale ...	0	5	357	4
24	**COAL** and shale mixed	0	10	358	2
25	Clay, soft ...	0	9	358	11
26	Shale, black ...	0	4	359	3
27	Under-clay, strong, sandy. — *Stigmaria*-rootlets	4	0	363	3
28	Sandstone, fine grained, ironstone-nodules with quartz-crystals ...	6	2	369	5
29	Shale, soft, blue ...	8	8	378	1
30	**COAL**	0	2	378	3
31	Under-clay ...	2	0	380	3
32	**COAL** ...	0	3	380	6
33	Under-clay, with ironstone-nodules.—*Stigmaria*-rootlets	1	4	381	10
34	Shales, grey, slaty, with ironstone-nodules ...	3	2	385	0

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
35	Shales, grey and bluish, soft	7	8	392	8
36	Sandstone, grey, hard ..	8	3	400	11
37	Shales, blue, grey and red, 10 beds	50	3	451	2
38	Sandstone, hard, with cleavage-planes	23	0	474	2
39	Shales, blue and black, 8 beds ...	35	10	510	0
40	**COAL**	0	5	510	5
41	Shale, sandy, and sandstones, mixed	11	6	521	11
42	Shales, red and greenish ...	4	8	526	7
43	Sandstone or strong slaty shale	10	10	537	5
44	Shale, red .	1	0	538	5
45	Sandstone ...	3	3	541	8
46	Shale, red ...	9	5	551	1
47	Sandstone, hard	12	6	563	7
48	Shale, blue, soft.—*Calamites*, reeds and threads of *coal* at bottom	15	7	579	2
49	**COAL** and shale, mixed irregularly	1	5	580	7
50	Shale, strong, sandy	4	7	585	2
51	Under-clay ...	3	3	588	5
52	Shale, blue, sandy	5	7	594	0
53	Sandstone .	9	7	603	7
54	Shales, blue and black. *Calamites* at top ...	5	9	609	4
55	Sandstone, hard ...	1	0	610	4
56	Shales, blue and black, 4 beds.—*Lingula* - shells and coprolites ...	9	11	620	3
57	Under-clay, grey, crumbly ...	9	6	629	9
58	Sandstone, hard, grey	31	7	661	4
59	Sandstone and hard blue shale ...	4	0	665	4
60	Sandstone, slaty, carbonaceous partings ...	2	6	667	10
61	Sandstone, strong, white	5	1	672	11
62	Sandstone, strong, numerous black partings. – *Calamites* and *Lepidodendron* near bottom ...	8	1	681	0
	Sydney Main Seam.				
63	**COAL**	6	0	687	0

DISCUSSION OF MR. W. LECK'S PAPER ON "AMBULANCE-INSTRUCTION AT MINES."*

Surgeon-Major GEORGE A. HUTTON (Honorary Organizing Commissioner of the St. John Ambulance Association) said that he desired to revive ambulance-work in all the mining-districts of the country, and to ask the members to support his recommendation, that every colliery and mine should have its ambulance-class. It was not sufficient that a few men, here and there, should know what to do with an injured man, but that every man, who had the time and opportunity should endeavour to gain first-aid knowledge. Before he went further, for the benefit of those present who might not be very clear as to the nature of ambulance-work, he wished to explain its true object and meaning. For instance, a collier in a pit had his leg broken by a fall of stone, his comrade who was next to him was an ambulance-man, and by means of a simple improvised splint and bandage, was able to put up the injured limb, and then, with

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 354 : and vol. xxvi., page 154.

a proper stretcher (kept down the pit), he and his companions removed him to bank, and to his own home or hospital without danger of making the injury worse by ignorant though kind handling, as was often done. Again in another colliery, several men were badly burnt, and the ambulance-men were able to render useful and valuable assistance in dressing the burns. In another case, an artery was wounded in the thigh, but the ambulance-man knew how, and where, to apply the pressure to stop the bleeding, and so life was saved. He (Major Hutton) remembered, some years ago, visiting an hospital in Lancashire, and a man was admitted whose leg had been nearly cut off. In this case, an ambulance-man had stopped the bleeding, and saved life, and then the man had been carefully carried a distance of 2 miles to the hospital, and thus spared a vast amount of pain and suffering. This case was a typical example of ambulance-work—the saving of life by the arrest of bleeding, and the alleviation of pain by careful transport; and these two cardinal points—the saving of life and the alleviation of pain, should be engraven in letters of gold in the hearts and memories of all ambulance-workers. And here, he too would remark for the information of the members of the medical profession, that they simply sought to render first-aid; and that they always impressed upon all pupils, that whenever they were called upon to render assistance, whether in broken bones, burns, bleeding, etc., they were never or any occasion to omit sending for the doctor. These instructions have been so carefully carried out, that no complaints have been made by any doctor—on the contrary, the members of the medical profession, all over the country, have given a loyal and active support to the movement.

Another point, upon which he (Major Hutton) held a strong opinion, was uniformity of instruction and examination, and the benefit of belonging to the St. John Ambulance Association. Miners may be said to amount to a big army of workers, and in these days of rapid locomotion, men migrate frequently from one district to another. If they are instructed in first-aid and the removal of the injured, under one well-organized system, the ambulance-men from different districts will at once understand each other, and as the St. John Association has branches all over the country, the value of uniform action in cases of injury, must be clear to everyone who values

good work. He (Major Hutton) might add that the work had now taken root in many of the Colonies, in British India, Australia, New Zealand, and he hoped that there would be a great development of ambulance-work, when South Africa became more settled.

All young men going to the Colonies, especially mining and mechanical engineers, should qualify themselves to render first-aid under the St. John Ambulance Association. He (Major Hutton) had served in South Africa for 4 years, and knew how valuable and useful such knowledge was in a country where it was often difficult to procure proper medical aid, and where the patient might have often to wait for many days or weeks before any doctor could be procured.

One material point in ambulance-work is, that it is voluntary. From experience in public matters, extending over a long number of years, he (Major Hutton) felt that the work was much better carried on by voluntary means, than by any Government department. When the Coal-mines Regulation Bill of 1887, was under discussion, he favoured what is now the rule (No. 34) that stretchers should be kept at every colliery, but that the instruction in first-aid should be entirely voluntary. He felt sure that the good sense of the men would not be slow to see the value of the instruction, and they would gladly avail themselves of it.

As far as St. John Ambulance work was concerned, he (Major Hutton) had no desire, as a practical man to theorize, nor to appeal to mere popular feeling on this question. He asked that every mine and colliery should be supplied with proper ambulances and stretchers, and for the men to be instructed in their use and to render first-aid. He asked the owners, managers and all in responsible positions to aid in spreading this knowledge; and lastly he called upon the men to assist themselves by attending the classes, which he trusted might soon be revived and extended at all collieries and mines. He felt sure that he would not appeal in vain for co-operation and support in the humane work of the St. John Ambulance Association.

The President (Mr. W. O. Wood) remarked that it was the rule at the South Hetton collieries, that deputies and overmen should attend ambulance-classes, but difficulty had been experienced in inducing hewers and stonemen to take an interest

therein. He suggested that the officials of the workmen's associations should be asked to take an interest in the ambulance-classes and to direct the attention of the lodges at the various collieries to the importance of obtaining instruction.

Mr. R. Donald Bain (H.M. Inspector of Mines) said that practically the whole of the collieries in the Durham mines-inspection district had joined the newly formed Ambulance League and the district comprising South Durham, Westmoreland and North Yorkshire had been divided into 10 centres. The members of each team would in the first place receive a certificate from the St. John Ambulance Association; the teams from the mines attached to the local centres would compete amongst themselves; and finally the 10 teams representing the local centres would compete at Durham for a challenge-shield. He hoped, with the assistance of a representative committee, that there would be at least 2,000 men under instruction in each year, and that the movement would be a lasting one. He had recently mentioned this matter to Mr. John Wilson, M.P., and that gentleman had volunteered to refer to it in the *Monthly Circular* issued to the members of the Durham Miners' Union.

Mr. William Leck (H.M. Inspector of Mines) drew attention to one of the suggestions in his paper that "managers might make it known that no young man would be considered qualified for promotion to the rank of a miner, unless he is in possession of the certificate or medallion, the qualifying badge of the St. John Ambulance Association. This has been done with happy results in at least one of the hæmatite-mines of Cumberland."

Mr. A. L. Steavenson (Durham) pointed out that the question appealed to them on two grounds:—(1) On that of humanity, as no one would like to be lying with a bleeding artery or a broken limb, without anybody being able to afford them the slightest assistance; and (2), there was the sordid monetary view; if a man had a broken leg it might become much worse, if he did not receive proper attention at once. Colliery-managers ought to select their deputy-overmen, as far as possible, from men who held ambulance-certificates; the deputies were always in the flat, and if an accident happened they would

be in attendance within 5 minutes. It had been suggested that no one should be allowed to sit for a certificate to manage a mine unless he held the certificate of the St. John Ambulance Association. However, many men lived at a distance from where lectures were delivered, and, therefore, it would be impracticable to make such a restriction, but he was in favour of marks being awarded for such an ambulance-qualification.

Mr. J. B. Atkinson (H.M. Inspector of Mines) said that Major Hutton favoured voluntary work in promoting ambulance-instruction. The Coal-mines Regulation and Quarries Acts required that appliances should be kept for ambulance-work, and it would be logical to go a step further and require that a certain class of men should acquire the necessary knowledge to make use of these appliances. It had been suggested, as Mr. Steavenson had mentioned, that ambulance-knowledge should be required in connection with colliery-managers' certificates; and the question had been brought before the Examination Boards in the various mines-inspection districts at the instigation of the Home Secretary. Managers might require that under-officials should hold ambulance certificates, and some form of compulsion should be adopted to secure a sufficient number of ambulance-men at collieries. The ambulance-certificate could be obtained after attending a course of five lectures, and there was no difficulty in any ordinary man securing the necessary qualifications.

Mr. J. H. Merivale (Broomhill) said it had been mentioned that colliery-owners and managers had always been in favour of ambulance-classes, but colliery-doctors ought also to be mentioned. In his own experience, colliery-doctors were most willing and kind, and there was no difficulty in persuading them, in most cases without fee, to devote a certain amount of time to the promotion of this most useful object. The great difficulty was the extraordinary conservatism of the North-country pitman. It would be an excellent plan, and quite feasible, if colliery-managers would follow the example of the President, and insist that overmen and deputies should hold ambulance-certificates. He thought that the examiners were perfectly justified in insisting on some knowledge of ambulance-work from candidates for colliery-managers' certificates; and in

Northumberland the examiners had been in the habit of asking questions on the subject, and awarding marks to the men who answered them satisfactorily.

Mr. W. Walker (H.M. Inspector of Mines) remarked that Mr. R. D. Bain had kindly given a challenge-shield to the Ambulance League that had been formed in the Durham mines-inspection district, and he hoped that the competition for it would be the means of encouraging the formation of ambulance-classes. It was also proposed that a sum of money should be given to each team that participated in the final competition, and the first and second teams would also receive medals. If all officials were required to hold ambulance-certificates, more interest would be taken by the men, especially by those who desired to be promoted. He thought that all deputies and waggon-waymen should hold ambulance-certificates, as they were, in most cases, the nearest officials to any workmen in a mine, when an accident happened.

Mr. J. G. Weeks (Bedlington) remarked that there was no necessity for compulsion or stimulation, at all events, at collieries in Northumberland. Ambulance-instruction had been given at the Bedlington collieries since 1885, and on several occasions Surgeon-Major Hutton had examined and addressed the classes. Stonemen, hewers, putters, drivers, and also the men's wives joined, in fact they had a large class of ladies. At the Bedlington collieries, even animals that had broken a leg had been put into splints. The classes had always been very popular.

Mr. A. L. Steavenson, referring to the observations of Mr. Atkinson, said that if the holding of ambulance-certificates were made imperative, funds must be provided by the Government for the payment of the doctors, who taught the classes. At the collieries belonging to Messrs. Bell Brothers, Limited, the doctors were paid, he thought, a fee of £2 2s. for a course of lectures, but he did not suppose that all colliery-owners would be willing to bear this charge.

Mr. C. H. Steavenson (Redheugh) suggested that ambulance-corps might be placed on a similar footing to volunteer corps, and the Government might be induced to give a grant for each proficient member.

Mr. F. Coulson (Sherburn) suggested that a list of the men, who held ambulance-certificates, should be posted in some conspicuous spot. In his own experience, a man had been injured within a short distance of another who was qualified to render first-aid, but his proficiency was not known at the time, and his services had not been utilized.

Surgeon-Major Hutton said that he was entirely opposed to compulsion in the matter. He favoured the General Rule, No. 34, in the Coal-mines Regulation Act, requiring that stretchers and ambulance should be provided, but he thought that instruction should be left to the good sense of the men. With reference to the examination for colliery-managers' certificates, the Examination Board for the Midland mines-inspection district did not compel the candidate to hold the certificate of the St. John Ambulance Association, but the candidates were given a few questions on the subject of ambulance. He knew that it was a general rule in the Midland district to require a man, who sought to be promoted, to hold an ambulance-certificate.

Mr. G. H. Kinahan's "Notes on Mining in Ireland" were read as follows:—

NOTES ON MINING IN IRELAND.

By G. H. KINAHAN, M.R.I.A., District Surveyor (Retired), H.M. Geological Survey, Ireland.

Introduction.—Mining and the winning of metals is now on a different basis from what it was in the last century. Chemistry and other sciences have been successfully introduced, so that poor ores, formerly valueless, can now be worked with more or less good prospects. On this account, some of the abandoned mining properties, supposed to be economically valueless, may now be worked to profit. This statement does not apply to all the abandoned mines, as for some there are no hopes: such as the pockets of lead-ore in the Carboniferous Limestone, that had definite limits. However, as these pockets are on special geological horizons, it is possible that other pockets, now unknown, may exist; but as there are no leads, or such like indications of the proximity of one pocket to another, looking for an unknown pocket is very like searching for a needle in a bundle of hay. The pockets now worked out usually had surface-indications, though a few of them were discovered by chance. Furthermore, elsewhere some of the regular mineral lodes that were once famous for their riches seem to have had their riches solely stored in the portions that are now exhausted.

It is remarkable how chance, if we may so call it, comes in to aid science. In the Transvaal the "banket" or "almond-rock," is a low-grade ore, seldom assaying much more than ½ ounce of gold to the ton. In mining, they have to bring up good with "dead-stuff," and at first all brought up was passed through the mills, which took considerably from the profits. The Kaffir boys, however, who have better eyesight than the whites, could detect the "pay-stuff" from the "dead-stuff," so now there is a sorting process; the ore after being wetted, is passed down on to a revolving table, and the boys, as the stuff revolves slowly past, pick out the barren pieces and throw them away.

According to popular belief, at the Ovoca mines, county Wicklow, the mode of recovering copper in solution was also due to chance. A miner stole a shovel, and hid it in a stream of the water pumped from the mine. Until the loss of the shovel was blown over, he did not go to take it away, and when he did, instead of an iron he found a copper shovel. Of course the "de'il was in the shovel:" and for a time he was rather uncomfortable, but at last he told his wife, who advised him to "make a clean breast to the master." The master having seen the shovel, had a barrow-load of old shovels thrown into the stream. This is the story as told in connection with the Ballygahan mine, but it is possible that the discovery may have been made elsewhere. At all events, the owner of the mine erected banks of launders in which scrap-iron was put to recover the copper in solution. The process was so successful that other mine-owners in the district followed his example. It is an inexpensive way of making a profit: as the only large expenses arise from the erecting of launders and the laying in of a store of scrap iron. There is an exhaustive paper on the subject by Messrs. Philip Argall and Gerrard A. Kinahan* in which the original process and later improvements are described. A process that has also been proposed is the erection of collecting-vats, and concentrating by chemical reactions the copper in the carbonates. Such a manipulation would be most costly, while with the Ovoca process pure or nearly pure copper is the result at a minimum cost.

The separation of ores by magnetism is an important aid in cleaning and dressing, as thereby ores that formerly could not be separated by the different dry and wet methods in vogue, are now amenable. The process is based upon the fact that substances behave differently under the influence of a strong magnetic current. The following minerals may be sorted out by magnetic separators:—(1) Magnetic ores: all iron-ores; compounds of titanium, tungsten, nickel, cobalt and manganese: oxidized and sulphide ores of copper, and certain sulphides of zinc. (2) Non-magnetic ores: lead-ores, silver-ores, tin-ores, and compounds of bismuth.

* "Notes on the Recovery of Copper from its Solution in Mine-drainage, with Special Reference to the Wicklow Mines," *Scientific Proceedings of the Royal Dublin Society*, new series, 1882, vol. iii., pages 302-328.

Magnetic separators are successful in Cornwall for separating wolfram from tin-ore; and in Italy for separating blende and copper-ores.

Engineers acquainted with Irish ores must at once see the great gain to be wrought in the winning and separation of ores, as admixtures now unprofitable (the expense of the chemical processes that have been tried far exceeding the value of the results) should by magnetic separation yield profitable results.

In these notes, it is proposed, as a preliminary, to mention the minerals or their ores, that at one time or another, gave a name to Ireland, on account of the revenues that accrued from their winning and manufacture; but these industries are now more or less obsolete, not on account of the minerals or their ores being exhausted, but on account of the very different circumstances prevailing now compared with those formerly existing. Among these standing out prominently are (1) gold and iron; and (2) silver and copper.

The present prospects of metal-mining will afterwards be briefly considered.

Gold.—Gold, at one time, must have been a staple export from the island; yet most of the early English historians would have us believe that all the Irish gold was imported in exchange for slaves. But more extraordinary still, in spite of ocular evidence to the contrary, quite recent writers have attempted to regenerate this canard. Dr. Gerrard Boate, who wrote in 1641,* would have us believe that before the English came the natives knew nothing of metallurgy; yet — Chichester in his report of 1609, was specially impressed with the superiority of the work of the Irish smiths over those of England. In place-names the work of the smith and artificer also are recorded.

The earliest record of Irish gold-workers seems to be the discovery of a settlement under the Bog of Cullen, near the boundaries of Tipperary and Limerick. The circumstances connected therewith prove that it must have been very ancient.† These artificers had their settlement in a wooded hollow, which was suddenly flooded either artificially or naturally, as all their implements were found just as left after a sudden flight.

* *Ireland's Natural History*, 1652, page 124.

† *Manual of the Geology of Ireland*, 1878, pages 339-346.

This flood killed the wood, a bog growing in its place. On this bog other trees subsequently grew, this second wood being also flooded and replaced by the recent bog. We therefore have four periods:—(1) The colony in the wood, (2) the first bog, (3) the second wood, and (4) the recent bog. It is hard to calculate how long the two bogs, respectively, took to grow, or how long the second wood lasted; but many ages must have passed since the gold-smelters lived in the wooded glen of Cullen. The genealogy of a family of goldsmiths is given in the *Book of Lismore*. They were descended from Olioll Olum, king of Munster, and followed the trade uninterruptedly for seven generations, from about 300 to 500 A.D.* In olden times, the plain of the Liffey was called Laighnigh-an-oir from its gold. According to the *Annals of the Four Masters*, gold-placers were worked in the valley of the Liffey and probably in the head-waters of the Slaney.† The western portion of county Wicklow and eastern Kildare have not been explored since the "time of the old men:" the more recent workings having been in the Woodenbridge district of eastern Wicklow.

In connection with a "gold-digging" or "streaming" there are the quartz-reefs, the shallow placers, the deep placers, dry-gulch placers and shelf or bar-placers. In the eastern Wicklow diggings, reefs have been unsuccessfully looked for. The gold was principally worked in shallow placers; and in a few places in the dry-gulch placers; but in modern times neither the deep nor the bar-placers have been explored.

The future of gold-mining in Ireland was very exhaustively entered into by the late Mr. Gerrard A. Kinahan in his paper on "The Mode of Occurrence and Winning of Gold in Ireland,"‡ and by the writer in his papers on "The Gold and Placer-mines of Wicklow,"§ and on "The Possibility of Gold being found in Quantity in County Wicklow."‖

Iron.—In prehistoric times, iron was probably known and worked, but the records of the implements made are now very sparse, as iron rusts or decays away so fast if buried. Rods of

* *O'Curry Lectures*, vol. iii., page 205.

† *Economic Geology of Ireland*, 1889, page 10.

‡ *Scientific Proceedings of the Royal Dublin Society*," new series, 1882, vol. iii., page 263.

§ *Quarterly Journal of Science*, 1878, vol. xv., pages 189-194.

‖ *Scientific Proceedings of the Royal Dublin Society*, new series, 1883, vol. iv., page 39.

peroxide of iron have, however, been found in some of the crannôgs, which probably are the last remains of buried implements.

One of the earliest authentic records of the smelting of Irish iron-ore and its manufacture, seems to be that left by Chichester (1609); who states in his report that on arriving in the country he found that the native smiths were smelting the ore in small bloomeries and manufacturing it into steel far superior to the English. During the troubled times, the Irish and the Anglo-Norman producers, whose old bloomeries and works are to be found in various places, seem to have died out; and the great boom in iron did not occur until after the English and Scotch settlers had taken up their abode in the country about 1600, the remains of their furnaces and other work being conspicuous.*

Dr. Gerrard Boate's *Ireland's Natural History*, chapter xvi., is descriptive "Of the Mines in Ireland, and in particular of the iron-mines." † This author says that some of Giraldus Cambrensis' statements are evidently untrue and fictitious and are due to his credulity; and we may say the same of the records left by Dr. Boate. Nevertheless, there is in places valuable information to be gleaned from it, such as his description of the iron-mines and works. From him we learn that there were three sorts of iron-mines:—(1) bog-mine, (2) rock-mine (hæmatite), and (3) clay-ironstone called by several names.‡ Of these the bog-ore is the richest, but, on account of its friable nature, in the melting it must be mingled with some of the other sorts. The rock-mine or ore, if melted by itself yields "very brittle iron," so that nearly invariably it was mixed with bog-ore. The clay-ironstone was of very different qualities, some being much richer than others.

The bog iron-ore nowadays does not seem to be exported or in any way used for smelting, although on account of its easy and cheap winning, it ought to be valuable to mix with some of the English ores.

Partly allied with the bog iron-ore, are the aluminous ores of county Antrim, of late years more or less extensively worked. This subject has been considered in Mr. Philip Argall's "Notes

* *Economic Geology of Ireland*, 1889, pages 63-64.

† Page 122. ‡ Page 125.

on the Tertiary Iron-ore Measures, Glenariff Valley, County Antrim,"* and in a paper by the writer on "The Iron-ore Measures of County Antrim."† In the latter, it is pointed out that these iron-ore measures for the most part appear to have been lacustrine deposits, which accumulated in shallow boggy lakes or ponds, in hollows on the ancient surface of the sheets of Eocene dolerites as found at the present time in the United States of America: and they were subsequently covered by the newer Miocene flows. At a later period, the lacustrine accumulation contracted, and dried away from the roof, and in the space thus formed the veins of pisolitic or pebble-ore were secreted. Some of these Ulster accumulations, however, were not on this geological horizon.

The Kainozoic iron-ore trade is of recent development. In 1609, — Chichester mentioned this ore, and in 1683 Dobbs suggested that it existed in Island Magee. An Earl of Antrim also considered that the ore had a future value, and when he sold his property he reserved the mining rights. Its value, however, was not generally known before 1861, when Dr. Ritchie specially directed attention to these ores—afterwards they were successfully worked until the depression in the iron-trade. The occurrence of the pisolitic ore is peculiar, for although it appears as if bedded, its genesis was evidently long subsequent to the formation of the associated rocks and ores.

Associated with the iron-ore measures is the alumite or alum-clay. This has been very profitably worked. It is allied to the French bauxite (with which it has been erroneously classed) and to the German wocheinite; but the typical alumite is superior to both the French and German clays. In the Irish mineral the alumina is the hydrated variety. In the others the alumina is both hydrated and anhydrous, and in all the known processes of alum-making the sulphuric acid only extracts the hydrated alumina, therefore, in the Continental minerals there is a loss of from 6 to 8 per cent.‡ The alumite is always associated with lignite; while where there is no lignite we find bole, a ferriferous clay very similar to Continental bauxite and wocheinite; it may

* *Scientific Proceedings of the Royal Dublin Society*, 1881, new series, vol. iii., pages 151 *et seq.*

† *Transactions of the Manchester Geological Society*, 1893, vol. xxii., page 458 *et seq.*

‡ *Economic Geology of Ireland*, 1889, pages 65 to 67.

therefore be suggested that the alumite is bole out of which the iron has been leached.

About thirty years ago, an extensive export trade in bog iron-ore, principally from county Donegal, sprang up: the stuff being required in a process for the purifying of coal-gas.* The raw product in itself was of little value; but after it had taken up the gas impurities, the "gas-waste" was so valuable that the exporters found it profitable to supply the ore free of cost, on condition that the "gas-waste" was returned to them. Mr. W. E. Adeney states "after it has been used for the purification of the gas, the ammonium salts are first extracted from the spent ore by means of water, the fine ferriferous powder deposited being very valuable in the manufacture of brown-paint. The residue then is dried and burnt for sulphuric-acid manufacture. The cinder left after burning off the sulphur can be sent back to be reused for washing gas." The export trade was of very short duration, as when it was found that the cinder was capable of being used over again only a very small quantity of the raw material was required to make up for the deficiency in the quantity due to the waste, while the impurities are being extracted. The trade ceased so suddenly, about fifteen years ago, that a quantity of the stuff ready raised for exportation, is now lying on the Donegal hills. In places on the Donegal quartzite-areas, there is a peculiar buff-coloured variety, an earthy chalybite. This, while the ore was being exported, was found to be more suitable for gas-purification than the ordinary ore; but it had to be raised and allowed to weather for a year, to allow the carbonate time to change into the peroxide. Special attention may be called to this ore, as it ought to be valuable as an addition in the manufacture of iron from some of the English and other ores.

A curious statement was recently made at a meeting in Cork, over which Sir Horace Plunkett presided: his subordinate mentioned as a triumph for his department, that they had discovered bog iron-ore in the county of Cork.† The discovery, however, was rather stale, considering that this ore was one of those smelted by the Earl of Cork in 1600. The lecturer evidently was rather innocent of his subject, but the statement

* It should be mentioned that the bog iron-ore may be hydrous or anhydrous. The latter is useless for gas purification: but Mr, Ritchie of Belfast had invented a process by which the anhydrous was changed into the hydrous variety.

† *Cork Constitution*, October 23rd, 1902.

being countenanced by Sir Horace Plunkett was rather pernicious, as already it has been quoted, and owners of at present nearly valueless ore have been led to believe they have valuable properties.

As to the ore in veins mentioned by Dr. Boate, most of the old workings are unknown and very little has been done with this class of ore since the Irish furnaces were extinguished. Now and again some of it has been raised and a little export trade began, but never to last any time. The ore is rather peculiar as rarely is it a red hæmatite, but usually an admixture of brown and red hæmatite: and, as pointed out by Dr. Boate, more or less siliceous.

Of clay-ironstone, there seems to be a nearly inexhaustible supply: as on one horizon in the Lower Coal-measure shales a little below the Earl's Hill or First Coal-seam, it occurs abundantly. These beds in various places were worked along their bassets by the iron-masters, and the ore-seams were so plentiful that rarely do the miners seem to have gone to any considerable depth.

Of late years, different attempts have been made in a few places to run a smelting trade with peat-fuel, especially in the Connaught coal-field, but none of the adventures have been crowned with success. Some of the beds are excessively rich, but a want of an economical fuel has been the great stumbling block. The Irish mineral coal is not suitable or plentiful enough for smelting purposes, while as yet no economic mode of working with the peat has been perfected.

Silver.—Silver, it is evident, was comparatively plentiful in olden times, as there are records in different places of numerous silver-mines. The ore usually worked was more or less argentiferous galenite; but some native silver was found in minor quantity.*

Dr. Boate† states that three silver-mines were discovered by the English. He mentions a mine in Antrim that gave 1 pound of silver to 30 pounds of lead: a mine on Coney Island in the estuary of the Sligo river, and Silvermines in the county Tipperary. The first two mines are now unrecorded and seem

* *Economic Geology of Ireland*, 1889, pages 11 and 12.

† *Ireland's Natural History*, 1652, page 141.

never since to have been worked. The locality of the Antrim mine is quite unknown, but Coney Island might be worth exploration. From the *Annals of the Four Masters* and other sources, however, we learn that mines in olden times were worked at Tulla, county Clare; at Carhoon, near Tynan, county Galway; and Ballygallion, near Inistioge, county Kilkenny (this is supposed to be the Argetros (*silverwood*) of the *Annals of the Four Masters* where silver shields were made, A. M. 3817); Garrane, near Toomavara, county Tipperary (this is supposed to be Rosargid (*silverwood*) of the *Annals of the Four Masters*); and Connary, county Wicklow, where stone and other rude mining implements were found.

Silvermines, county Tipperary, is said by Dr. Boate to have been discovered by the English; but the researches made during the last century and statements in the *Annals of the Four Masters* would suggest that it had been previously worked by the Irish. When the mines were destroyed by the O'Kennedy's in 1641 they were being worked by Dutch and English miners.* The Silvermines mineral channel is interesting, being a contact-lode at or near the junction of the Carboniferous and Ordovician rocks, but subsequently more or less faulted. It extends for at least 30 miles, from Gallow's Hill, county Clare, on the westward, to Toomavara on the eastward. Along this line, old mines were worked at the previously mentioned Garrane and at Silvermines; while in the western extension, county Clare, the ground is as yet untried, although there are good indications, which would suggest that in other places along this contact break, profitable lodes may yet be discovered. The Silvermines, since 1600, have been worked by different English adventurers.† Here there are some complicated faults.‡ Dr. Boate states that the ores worked here were one "of a reddish colour, hard and glistering [evidently blende]; the other is like a marle, something blewish, and more soft than the red [galenite]; and this was counted the best, producing most silver, whereas the other, or glistering sort, was very barren."§ It would appear that the

* *Ireland's Natural History*, 1652, page 144.

† *Economic Geology of Ireland*, 1889, page 100.

‡ *Memoirs of the Geological Survey of Ireland, Explanations to accompany Sheet* 134, pages 31 to 41.

§ *Ireland's Natural History*, 1652, page 142.

blende was run into the old workings, where it decomposed and changed its original character: as about 1858 in the ochreous gossan found in the old men's working, near the Mining Company offices, a whitish nearly transparent crystalline mineral was observed, occurring in veins, pipes and hollow concretions or scattered through the gossan, which Dr. Apjohn pronounced to be electric calamine or silicate of zinc. With this was found a little of the carbonates and sulphides.

According to the report of H.M. inspector of mines, 1902, just published, explorations are now being made "and a quantity of calamine, copper-pyrites and lead-ore have been obtained, all being still in stock at the mine."* The state of the mines in 1861 was recorded in Mr. A. B. Wynne's report.† It might be profitable to explore some of the other ancient silver and lead-mines, for elsewhere, as a general rule, the ancient mines that in modern times have been explored, have been found more or less profitable.

Copper.—Copper must have been well known by the early inhabitants, if we are to judge by the innumerable bronze and copper-implements that are continually being found: yet so far as the writer has as yet learned, no mention of ancient copper-mines are found in the *Annals of the Four Masters*. However, in different places in course of mining operations during the last century, "old men's workings" have been found. In county Tipperary, ancient workings for copper-ore exist at Gortnahalla, near Borrisoleigh: at Lackamore near Newport, ancient tools were exhumed in the "old men's workings"; and also at Ballycohen or Hollyford near Cappawhite. In county Kerry, at Muckross, and Ross Island, Killarney, are very ancient mines, recorded by Nennius, a ninth century writer, who mentions copper, lead, tin and iron. Smith, in his *Natural History of Kerry*, states that he found ore containing tin near the lake; but in subsequent records no mention of it is made. When working the copper-mine at Muckross in 1794, Mr. Raspe discovered cobalt-bloom and grey cobalt. After the discovery little remained to be utilized, as all the accumulation except about 20 tons had been run into the lake as rubbish. The

* *Report on the Inspection of Mines and Quarries in the Manchester and Ireland District, 1902*, by Mr. John Gerrard, page 34.

† *Memoirs of the Geological Survey of Ireland, Explanations to accompany Sheet* 134, pages 31 to 42.

small portion saved had been surreptitiously carried away by a miner who recognized it as erythrine or arseniate of cobalt.*

At the Stage lode, Knockmahon, county Waterford, in "old men's workings" were found rude stone and wooden implements. In this lode, there were also silver, lead, zinc and cobalt. In the Ovoca mineral channel, county Wicklow, in places there seem to have been very old workings, but possibly these were for lead.

In west Cork are Devonian rocks, called on the Geological Survey maps "Lower Old Red Sandstone" and "Upper or Yellow Sandstone." The latter contain many metalliferous beds in which the ore is principally grey copper-ore (tetrahedrite) the backs of the beds weathering into the carbonate or the black oxide. In some places, certain rocks in the summer months become a greenish-blue from the tetrahedrite weathering into carbonate, but in the winter-rains these rocks are washed quite clean: where does the copper go to? A rather extraordinary statement has been made by one of Sir Horace Plunkett's experts in a work called *Ireland: Industrial and Agricultural*, 1902. This is to the effect that in Ireland the tetrahedrite has been erroneously mistaken for copper-glance (redruthite); now the latter mineral is a rare Irish ore, as it has only been detected in a few localities, while in south-west Cork, the most prevailing minerals are the grey ores, tetrahedrites (argentiferous and possibly auriferous) occurring both in the beds and lodes.

The Upper or Yellow Sandstone is the productive zone in south-west Cork. It has been found that although the quartz-lodes traverse both the upper and lower, yet the moment they pass the limits and penetrate into the Lower Old Red Sandstone, they are barren. This is very conspicuous in the Bearhaven or Allihies mines, as the champion quartz-lode occurs in both groups, but was found to be quite unfertile when the boundary was crossed. The ore was first noted in a great quartz-ramp running as a small promontory into the sea at Allihies. To the eastward this quartz-lode becomes a horse, a siliceous breccia made up of fragments of the country-rock; further east, in the Mountain mine there were, at grass, two quartz-lodes more or less profitable, that in depth joined, to be again separated by a horse of country-rock before they became unprofitable. To the

* Sir R. Kane.

eastward the Mountain mine is cut off by a cross-course and at the latter there was a large pocket of the carbonate and oxide, said, undressed, to return 90 units of copper.

While these mines were in "riches," numerous shafts were sunk on all the different quartz-lodes in the Lower Old Red Sandstone with unsatisfactory results. The Mountain and north and south lodes became unprofitable, and the mines were eventually abandoned. The late Sir Warington Smyth stated, in connection with the Mountain mine, that at 900 feet "the chief point of note about the lode here was, however, that from its hardness and moderate admixture of ore, it would have been, if small, unprofitable, whilst from its great size, allowing of operations on a large scale, it proved highly remunerative."*

It may be suggested, as the Mountain and other mines have now for many years been flooded, that the mine-water must be more or less impregnated with copper, and that the water might be pumped out, and the copper profitably precipitated therefrom.

In south-west Cork, to the southward and south-east of Bantry Bay, there are some mining setts which ought to be remunerative, and there are the metalliferous beds that were formerly not very profitable; but now, on account of modern methods, they may be worth working. Possibly in them, the ore might be concentrated by a magnetic process; or after the stuff was ground and the ore separated by steeping, puddling and washing, the copper might be won from the water by the cementation-process already mentioned.

At Kilcrohane (Sheep Head) mine, the copper-ore is auriferous; also at Carrigacat or Dhurode. The last named are said to be very ancient. Copper-ore from Ballycummisk has been proved to be auriferous by a recent analysis. At Derrycarhoon, near Ballydehob, a very ancient working was discovered by Mr. Charles Thomas. The excavation was 60 feet long by 60 feet deep and 4 feet wide between well defined walls. All the stuff in the working had been removed by the "old men," as not a trace of it remained. Wooden and stone implements, a curved tube of oak, and a primitive ladder, an oaken pole with rude steps cut in its sides, were found in the old workings. All traces of this ancient working were obliterated by a surface-growth of peat over 14 feet thick: this may represent a period of 3,000 years or more.

* *Memoirs of the Geological Survey of Ireland, Explanations to accompany Sheets* 197, etc., pages 30-32.

In county Tyrone, there is another tract of Devonian rocks. Here, at the mearing between the Pomeroy and Carrickmore manors, are metalliferous quartz-lodes. This district may be considered a virgin one, as except in the vicinity of the Dungannon water-works, where there were some shallow trials on a coppery lode, no explorations have been made. This is one of the two places where copper-glance (redruthite) is recorded as having been found in Ireland. The lodes at the Pomeroy and Carrickmore mearing seem worthy of research, more especially as the exploration ought not to be expensive.*

The Bonmahon or Knockmahon mines, county Waterford, were worked in prehistoric times; as shown in the "old men's workings," at the Stage lode, where rude stone and wooden implements were found. In this lode, besides the copper there was also silver-lead, zinc and cobalt. These mines have had a very varying record. From the time of Queen Elizabeth down to 1730, some of the lodes at intervals, appear to have been worked: at the latter date they were in the hands of Mr. Hume, who for some years worked the Stage lode very successfully. Next we hear of Col. Hall and Mr. Galway, who spent a large sum unsuccessfully. In 1796 the mines passed to the Hibernia Mining Company. The mine was acquired, in 1824, by the Mining Company of Ireland, who until 1876, carried on mining with varying success; and about 1880 the works were abandoned, as the lodes had become unprofitable. The future of these mines is obscure, as there seems no hope for them; but it must be remembered that after many failures the net profit in 1862 was £20,000.†

The mineral-range is county Wicklow on which the Ovoca mines are situated, is possibly at present the most important undeveloped mineral ground in Ireland.‡ This range extends from the Deputy's Pass southward of Wicklow town, all but continuously in a southward direction to the Ovoca river, and from there to the flanks of Croaghan-Kinshella, in all a distance of about 15 miles. To the eastward, in the range, the lodes are ordinary lodes in the country-rock; but in the East and West

* *Economic Geology of Ireland*, 1889, page 33.

† *Memoirs of the Geological Survey of Ireland*, *Explanations to accompany Sheet* 168, page 81.

‡ *Economic Geology of Ireland*, 1889, pages 108-119.

Ovoca mines, there is a peculiar wedge-shaped channel in the country-rock, in which there are one or two main lodes. This channel was formerly supposed to run with the strike and dip of the country-rock "but recent research has shown that although the general direction of the lodes, may be more or less with the strike of the 'country-rocks,' yet the channel and lodes always cross the latter, although sometimes at a very small angle, while in depth both dip at a greater angle than the 'country-rocks.'"* This channel is conspicuous in the mining setts, east and west of the Ovoca river, but it does not occur to the eastward in the Ballycapple setts, or westward in those of South-west Ovoca or Knocknamohill, or in the Carysfort mines to the south of the Darragh water. In the country-rock north of the East and West Ovoca setts, there is a north lode. This, it may be suggested, is the lode to the eastward in Ballycapple and one of the lodes to the south-westward in the Knocknamohill and Carysfort mining sett. Possibly, against such a supposition, it may be pointed out that in the Knocknamohill sett there are two well-marked lodes and in those of Carysfort there are three.

Beginning to the eastward. In the country east of the fault of the Deputy's Pass, no lode is recorded. West of this fault in the Ballycapple setts, townlands of Ballycapple and Ballard, the iron-back of the lode was worked by Messrs. Chamney of Shillelagh, the ore being superior, a mixture of magnetite and hæmatite ores. The lode was never worked, but from fragments in the attals of a trial on it, it seemed to be a coppery pyrites.

The range between Ballycapple and Kilmacoo, in a south-west line of about 3 miles, is very little known. In the townland of Rockfield, 1 mile north-north-east of Kilmacoo is an assembly of "shode-stones" very like those of the Ovoca channel.

The fault, a little east of Kilmacoo or Connary cross-roads, cuts off on the east the Ovoca channel. In this channel, between this fault and the Ovoca river, lie the East Ovoca mines in two groups:—To the north-eastward, there are Kilmacoo, Connary and the Magpie or East Cronebane; and to the south-westward, West Cronebane and Tigroney. These deposits are very exhaustively described in Mr. P. H. Argall's memoir† and by the present writer.‡

* *Economic Geology of Ireland*, 1889, page 113.

† "Notes on the Ancient and Recent Mining Operations in the East Ovoca District," *Scientific Proceedings of the Royal Dublin Society*, new series, 1880, vol. ii., page 211.

‡ *Economic Geology of Ireland*, 1889, page 113.

There are, however, special features of interest in the Kilmacoo, Connary and Magpie setts; there being more or less considerable quantities of that peculiar ore kilmacooite or bluestone. This mineral seems to be an admixture of the sulphides of zinc, lead, iron, copper, antimony, arsenic and silver, with a trace of gold; it varies, however, in its composition. Up to the present time, no economical process has been found by which to disentangle the different ores. It has, however, been suggested that this could be done by magnetic separation, but as yet the experiments are not completed.

To the westward of the Magpie mine, between it and the West Cronebane mine is the tract called the "Yellow Bottoms," an area occupied by a surface-field of ochre; this during explorations made in 1879 and 1880 was proved to obscure a massive sulphur-ore lode (coppery pyrites). The Yellow Bottoms was rather a puzzle, as evidently it had been honeycombed by numerous pits. The latter have been explained by recent explorations, as now it is known that under the ochre there was a "gossan-lode" of black auriferous copper-ore, and this was won by the "old men" on the same principle that placer-mines for gold are worked at the present day.

The ores in the channel-lodes, to the east of the Yellow Bottoms are different from those on the west. In this division, there are two main lodes in the channel, both are wedge-shaped. The walls closing in depth on account of the hanging or south wall, standing more perpendicular than the foot or north wall —some of the sulphur-ore in the north lode still remains, though not much, as it has been bottomed in places; but in the deepest working, at the William shaft, the walls again appear to be opening. In the Magpie shaft, the lode in depth is cut out by a granite-protrusion or intrusion.

Tin.—Tin-ore must occur *in situ* somewhere in the Ovoca district, on account of the quantity found in "the streaming" for gold in the Goldmine valley; it may, therefore, be suggested as a possibility, that, as in Cornwall when the copper in the lodes die out (especially if in granite) at a greater depth, tin-ore may replace the copper-ore; here, therefore, in the Ovoca mines the same thing may take place. Tin-ore in the streaming and not as yet found *in situ* is hard to explain.

The granite of Croaghan-Kinshella is the young granite probably of the same age as the Dartmoor or young granite (Devonian) of Cornwall. This may account for the tin-ore in Cornwall and Wicklow: but the latter is a puzzle.

The prehistoric Irish were extensive workers in bronze, as is proved by the numerous implements and other relics found scattered over the county. Dr. P. W. Joyce points out that *aerarius* is equivalent to *cerd*, the first literally signifying a worker in brass (possibly bronze): also that Ballynagard (Irish: *Baile-na-gcerd*), the town of the artificers or brass-workers is not an uncommon place-name in Ireland. Besides there are the old habitations, raths and such like, in which are found crucibles, moulds, and other implements of their trade. Brass at the present day is an alloy of copper and zinc, while bronze is the alloy of copper and tin: these ancient Irish implements may be of copper, but most of them are of bronze (tin and copper) and rarely if ever, of modern brass (zinc and copper), as we are informed by Dr. George Coffey, keeper of the collection of antiquities of the Royal Irish Academy. It therefore becomes a question: Where did the ancient Irish get their tin? Another is: Why did they not utilize zinc which they had in abundance? It should be mentioned that lead is found in some of the later ancient "bronzes," also traces of iron.

At the present day, the following are the only recorded localities for tin:—Dalkey, county Dublin, and the Goldmine valley, county Wicklow. Nevertheless, some of the old historians mention it as having been found near the Lakes of Killarney, county Kerry.* There is a vague rumour that it has also been found in the copper-mine at Kilcrohane (Sheep Head), county Cork.

An area that probably has a future is that of the metamorphic and granitic rocks, west of Lough Corrib, county Galway or the Oughterard district. Here there are many lodes and indications of copper, sulphur-ores (pyrite and pyrrhotite), lead and zinc, some rich bunches having already been extracted. All the mining operations have been on a small scale, proving the lodes at the surface, but not in depth.

* *Natural History of Kerry*, by — Smith, and *Economic Geology of Ireland*, 1889, page 11.

Salt.—Irish minerals that seem to be kept very much in the background are salt, and steatite, with its relative pyrophyllite.

Possibly the only salt-measures are those in the Trias of county Antrim. They have been proved to exist from Eden on Belfast Lough northward to Larne; yet they have only been utilized at Duncrue. Here the salt-measures are from 100 to 160 feet thick. In the old pit, there were over 100 feet of salt, 13 feet being rock-salt, the rest of the thickness being impure. In other portions of the area, bore-holes or pits might be put down, and by them the salt-measures flooded, thus causing lixiviation and generating a lye, which should be pumped up and evaporated to produce lixivial salt. According to Prof. Dana,* at the principal salt-springs in the United States of America, the amount of brine or lye required for a bushel of salt varies from 30 to 450 gallons; while it takes, in accordance with the quality of the beds from which the salt is lixiviated, from a month to twelve months in the Austrian mines to saturate the water. In Antrim, there ought to be facilities for working, as the pits or bore-holes could be flooded with sea-water and thus hasten the saturation. Sea-water ought to give a bushel of salt from 200 to 300 gallons, but the result must vary greatly, as some waters are more saline than others. Very poor water ought to be remunerative, as the American wells at Boone's Lick, Missouri, require 450 gallons for 1 bushel of salt. It would, therefore, appear, if the salt-measures were worked by the lixiviation method, that the adventure would be remunerative.

Formerly, salt-works and pans for the manufacture of salt from sea-water were to be met with in various places on the Irish coast. Some of the works, like those at Slade, Hook Head, county Wexford, were very extensive. Others had large shallow troughs or pans cut in sheets of rock for aërial evaporation, like those at Salt Hill, county Dublin, which were in existence till after the Kingstown railway was made; or like those at the salt-pans on the shore of Lough Swilly, county Donegal, where there were large metal boilers in which the lye was boiled. These works on Lough Swilly were in existence till all the peat in the vicinity was exhausted, the boilers being *in situ* a few years ago. Here the old tenant stated that rock-salt

* *Manual of Mineralogy*, 1871, page 106.

used to be imported and stewed down with the sea-water lye. The only survivors of these old works still in existence are those of Messrs. Flower and McDonald at Balbriggan, county Dublin, where superior salt for all purposes is manufactured. Here they add to the sea-water lye rock-salt from Duncrue, county Antrim.

Steatite.—The hydrous silicate of magnesia, steatite, occurs in mass on the islands of Bofin and Shark, off the coast of Galway, but belonging to county Mayo. There are pseudomorphs after dolerite. A portion of the mass on Bofin island is of a very superior quality. In Claggan, Achill island, county Mayo, there is an irregular bunch or pocket-vein, in part crystalline and very pure.

In county Donegal, in various places, there is pyrophyllite, the hydrous silicate of alumina. A bed (?) of this, at Carrowtrasna, was for some time worked profitably and sent into the market as steatite and used as a lubricator. At Crohy Head, there is a vein or bed said to be steatite.

Rocks of the saponaceous class are recorded in the counties of Antrim, Cork, Donegal, Galway, Mayo and Wicklow. These minerals may occur in many other places, as they have not been carefully looked for. In county Donegal, the compact variety, or camstone, is recorded. This formerly was much used for architectural purposes.

Fullers' Earth.—Beds of steatitic clay or fullers' earth are found in different places, and formerly were much used for abstracting grease from woollen articles, while in county Galway they are still used for that purpose.

Pyrophyllite.—Pyrophyllite has been used in the manufacture of lubricators and as packing for pistons in machinery. It contains 30 units of alumina and may possibly, therefore, be utilized in the manufacture of alum and aluminium. Steatite nearly invariably occurs as a subordinate adjunct of the intrusive rocks forming veins and masses of more or less pure silicate of magnesia. In county Donegal the pyrophyllite seems to occur in beds as if it were a methylotic sedimentary tuffose rock. The weathered back is a friable saponaceous substance.

Molybdenite.—Of late, in the manufacture of steel, experiments have been made with molybdenum. As yet they seem to be unsuccessful, but at any time there may be a demand for this metal: it may be mentioned, therefore, that molybdenite (the sulphide) and molybdite (the oxide) occur in quantities in a massive granitoid ramp that comes up through an intrude of black granite (Tertiary) at Murvey, a few miles west of Roundstone, county Galway. The ramp stands up above ground, as a wide course; if, therefore, there arose a demand for the ores, the winning would be at a minimum cost, as all that would be required would be ordinary quarrying.

Mr. J. Holms Pollok, B.Sc., F.C.S. (Dublin) wrote that Mr. Kinahan's interesting paper was certain of an enthusiastic welcome from those interested in the development of the metallurgical, mineral and mining interests of Ireland. And for that purpose, it was necessary not only that the history of mining and metallurgy in that country should be kept alive, but that an interest should be awakened in metallurgical chemistry and mineral analysis in the various colleges in Ireland.

He regretted that Mr. Kinahan should lay such stress upon the occurrence of gold in Ireland. No one had ever found a single stringer of quartz that assayed 1 ounce per ton or a large reef that assayed 2½ pennyweights per ton. He (Mr. Pollok) had found little stringers of quartz, all along the sides of Goldmine valley, that assayed ½ pennyweight per ton. In Howth, he had known of patches of quartz with 2 pennyweights per ton, and the same at Lambay, but these were absolutely valueless, and there was no reasonable prospect of payable gold being found in any part of Ireland. Of course, a few nuggets had been found, but the source of nuggets was difficult to explain in more countries than Ireland. The occurrence of gold in the beds of streams, was easily accounted for by ages of concentration from the exceedingly poor quartz in the adjoining country-rock.

It was in the direction of the examination and development of mines of iron, copper, lead, zinc, silver, coal, fire-clay, barytes, salt, kieselguhr, chalk, slate, marble, china-clay and the like, and possibly of molybdenum, cobalt and tin that one might reasonably look for a profitable return. To take coal, for

instance, it is known that there is coal in Ireland, but it is so full of pyrites as to be of little value. He suggested that an engineer should investigate the precise nature of the coal, the manner in which the pyrites is associated with it, and the best manner of separating it from the coal: but there was no possible inducement for anyone to do this, unless he were paid by the owners of the coal-mines.

The fact that the ancient Irish did not use zinc, in place of tin to alloy with copper, although they had the former metal in abundance, was easily explained, as the metallurgy of zinc was much more difficult than that of tin, and the method of reduction was not thoroughly understood by the ancients.

Colonel Hugh H. Stewart (London, S.W.) wrote that he was well acquainted with the district in county Tyrone, containing the tract of metamorphic and Devonian rocks, mentioned by Mr. Kinahan. Not being a geologist or mining engineer, he (Mr. Stewart) was unable to afford technical information, but the existence of mineral-deposits was evident even to untrained intelligence. Moreover, the number of spas, which Mr. Kinahan, on the occasion of an examination of the locality made about 12 years ago, declared to be strongly impregnated with copper, pointed to the probability of the existence of a lode of considerable magnitude, especially as the spas appeared to run in a regular chain on a north-west to south-east line. Some of these spas were remarkably strong, so much so that the inhabitants were unable to use the water for cooking purposes. The following paragraphs had been taken from a report upon this subject:—

(1) *Metamorphic and Granitic Rocks.*—On account of the large overbearing of drift and bog, none of the mineral-veins could be satisfactorily traced: no open-cuts were made; no costeeming pits or boring; the survey being solely confined to an examination of the spa-wells, but some of these hereafter mentioned may suggest the expediency of a more extended search, more especially as at the time (May) the spas were not at their full strength.

(2) *Metamorphic Rocks.*—In the townland of Altdrumman, immediately south-west of Lough Fingrean (County Tyrone, Ordnance sheet, No. 27) there are three coppery spas, and a little to the eastward in Lough Macrory, near Dermoot Grannia Bed, a strong chalybeate-spa. About 3 miles to the eastward, in Creggan, on an east-and-west line, are three coppery spas, which possibly indicate a coppery lode, as may also the coppery spas hereafter mentioned in the Devonian rocks. In the townland of Lough Macrory (Ordnance sheet, No. 36) south of the shooting-lodge, there are slightly coppery spas, and there are two spas of the same kind, 2½ miles to the south-east near Aghnagreggan Bridge.

(3) *Lower Devonian Rocks.*—Near the east mearing of the Carrickmore estate (Ordnance sheets, Nos. 37 and 45) there are numerous spas, as a general rule more or less coppery. A remarkable spa occurs on the boundary of Sluggan and Inishatieve, having the flavour of Harrogate water, and to the extreme north of Inishatieve there are also strong spas.

The chief means of preventing or killing mining industries in Ireland had been the policy of free imports, which had made it not worth while to develop the country or exploit or search for any latent ores or other products that involved any expense. Most of the large towns, being on the seaboard, access to them was more readily obtained from the Continent by sea than from the interior of Ireland by rail. Mining required a protective tariff and, that once obtained, many industries now dead or dying in Ireland would revive.

Prof. Grenville A. J. Cole (Royal College of Science for Ireland, Dublin) wrote that the extraction of copper by placing iron objects in the water flowing from the mines had been, of course, performed in many countries, and was practised in Hungary in the seventeenth century. Mr. Kinahan did not refer to Mr. E. St. J. Lyburn's paper on "Prospecting for Gold in County Wicklow, and an Examination of Irish Rocks for Gold and Silver,"* which shows how the critical area in county Wicklow is not open to prospectors.

In view of the formation of pisolitic iron-ores in recent lakes, it seems improbable that the structure of the Kainozoic ores of Antrim is secondary, as suggested by Mr. Kinahan in his paper. The iron-ores, in fact, appear to have formed part of the lacustrine series of deposits. The bauxite in the same deposits is at present displaced by French bauxite as a source of aluminium, but it is still worked for alum. Attention may be directed to Mr. Thomas H. Holland's recent work in India on the connexion between bauxite and ferruginous deposits, such as laterite.†

He (Prof. Cole) believed that he was the "expert" referred to later as having stated "that in Ireland the tetrahedrite has been erroneously mistaken for copper-glance."‡ The state-

* *Scientific Proceedings of the Royal Dublin Society*, 1901, new series, vol. ix., page 422.

† *Geological Magazine*, 1903, vol. xl., page 59.

‡ *Trans. Inst. M.E.*, 1903, vol. xxvi., page 275.

ment made in *Ireland: Industrial and Agricultural, 1902*,* was that the reverse mistake in nomenclature had occurred; and he (Prof. Cole) believed that much, at least, of Mr. Kinahan's grey copper-ore would be found to be really copper-glance. Sir R. Kane† used "grey copper-ore" in this sense, and described it as "subsulphuret of copper."

Mr. H. J. Seymour‡ had added the Mourne mountains as a new locality for cassiterite in Ireland, the specimens being, however, merely minute crystals.

The present position of the salt-industry, near Kilroot and Carrickfergus, showed more activity than Mr. Kinahan had supposed.

The steatite referred to somewhat dubiously at Crohy Head is a massive talc-schist, and had been extensively excavated, but the works were, at present, closed.

Mr. E. Henry Davies (London) wrote that, in reading through the excellent paper by Mr. Kinahan on the subject of mining in Ireland, a matter on which he is one of the best authorities, he (Mr. Davies) was struck by the fact that he did not allude to the endeavours now being made to revive the mining industries of that country. Mr. Kinahan rightly referred to the successful mines of the past, and very properly indicated the points where, from his great experience, the mining operations of the future should be conducted.

One of Mr. Kinahan's suggestions based on the recollections of himself and of Mr. Philip Argall of Denver, U.S.A., was now being acted upon, and with results which amply confirm their anticipations. He referred to the exploration-works which have recently been undertaken by the Ovoca Copper Syndicate to locate and prove the existence of a large body of low-grade copper-ore, immediately under the alluvial covering at the Cronebane mines. This mass of ore, which at the time was completely invisible, was said to contain about $2\frac{1}{2}$ per cent. of copper, and the recent exploration-works have proved that for a length of 700 feet, it has a width of about 50 feet and on a most careful sampling and assay of 5 tons, yields as an

* Page 20.

† *Industrial Resources of Ireland*, 1845, second edition, page 182.

‡ *Scientific Proceedings of the Royal Dublin Society*, 1903, vol. ix., page 583.

average 2·79 per cent. of copper, and contains gold and silver, in addition, to the value of 6s. per ton. This more than confirms the anticipated results; and, as the quantity seems to be inexhaustible, there is every prospect of this portion of the mineral-wealth of Ireland being worked to the profit of the old country, and also to that of the adventurers. In their researches after copper, an immense mass of white clay was found, and it promises to become a valuable part of their property. He (Mr. Davies) understood that the scheme included the unwatering of the Connary mines from the level of the railway, by means of a long adit-level, which should intersect all the lodes at a depth of some 700 feet below the surface, thus laying dry the Cronebane and Connary mines to that depth. It is proposed to extract a mixture of the two ores to the extent of 300 tons a day, and smelt them on the spot, as owing to the excess of sulphur in the one and of silica in the other, an ideal ore for pyritic smelting is thus obtained. In addition to the ores which they will obtain by mining they will also derive considerable profit by the precipitation of copper from the water, reputed to contain 40 grains of copper per gallon, flowing from the old workings.

Prof. J. P. O'Reilly (Dublin) wrote that the mineral statistics for the last available year furnish solid data for consideration and discussion. The total values of the ores, minerals and rocks raised in Ireland were £244,234 in 1901, and £235,053 in 1902. The principal items for 1902 are:—Igneous rocks, 222,121 tons, value £70,654; coal, 108,737 tons, value £53,197; and limestone, 446,243 tons, value £41,192; the total of these three being £165,043. And of the whole mineral products of Ireland raised in 1902, those produced by quarrying account for 50 per cent. of the total value, leaving but a small margin for the other individual minerals taken in detail. This practically measures the extent of mining in Ireland at the present time.

Mineral deposits exist in Ireland well worthy of further careful and skilled study, and many of them, if not all, are referred to by Mr. Kinahan. Wicklow is undoubtedly a mineral district well worthy of exploration and careful study. The mines were well worked and very productive, up to 1860 or 1870, in coppery pyrites. The Huelva-district minerals then drove these ores out of the

market, and practically closed the mines: a small production has since been maintained, and in 1902, 444 tons of this ore yielding 9 tons of metal are given with a value of £380. Nothing is said as regards precipitate copper, and yet the deposit is particularly favourable to the development of that form of copper-production. The old workings, containing backs of coppery pyrites, are very extensive, and still produce much copper-solution. As regards these mines, Sir Warington Smyth's work thereon, published among the series of the Royal School of Mines, is well worth reading. Mr. Cruise also gave a notice of them in the Memoirs of the Geological Survey, and Mr. Weaver's excellent report, although more than a hundred years old, is well worth examination and study. Much has been written and done as regards the occurrence of gold, but not enough by any means. There are so many districts of older crystalline and eruptive rocks in Ireland, particularly of diorites, and the amount of actual research and assaying is so small, that there is ground for thinking that gold may be found, in minute quantities it is true, in many rocks not now considered as being gold-bearing. He submitted a small contribution* in this way, done on his own account, and he had in hand results, in addition, of interest. As experienced miners knew, a great deal of ground had to be gone over, and many careful assays must be made before working results could be attained.

Mr. Kinahan refers to the pockets of galena which have been worked in the Carboniferous Limestone, more particularly in the Silvermines district, county Tipperary. Having been engaged in working the zinc-deposit there during the "sixties," he (Prof. O'Reilly) could speak of these mines from actual experience and knowledge. The lode with which the deposit is connected is one of the most remarkable in Ireland, both as regards the extent and the variety of ores which it has produced. Historically, economically and geologically, no more interesting mining district exists in Ireland; and he had no doubt that further search and development would lead to interesting discoveries. The zinc-ores are relatively poor, rarely having reached 45 per cent. of zinc, but the great difficulty and

* "Notes on Some Assays for Gold of Rocks occurring in the Neighbourhood of Dublin," *Scientific Proceedings of the Royal Dublin Society*, 1890, new series, vol. vi., page 450.

the essential impediment to the successful and continuous working of these mines was the heavy cost of carriage to market, mainly Swansea.

Some of the galena-deposits in the Carboniferous Limestone deserve attention, such as those which were formerly worked about Dublin, one of which at least remains in evidence to this day, that is, the vein that crosses the tram-line near the baths on the road to Dollymount. It is known that lead was wrought there, and that the works were drowned by the sea-water; and two old shafts, one on the shore, attest the fact. Other veins were found and worked quite near the city. It is almost certain that these veins form the fillings of main joints in the limestone, that they have pretty nearly the same general direction, and that if the known ones were carefully mapped and correlated with the systems of jointing known to exist in the district, lines could be laid down for further search; and, as they lie near the surface, such veins present favourable conditions for working.

The serpentine-deposits of the west are not mentioned by Mr. Kinahan, but they are worthy of examination at the present time. The rock, as such, is worked and shipped to the United States, where it is fashioned into *articles de vertu* and imported into Ireland, where it may be seen in many of our shops dealing in "knick-knacks." But mineralogically the rock presents another and very high point of interest, owing to the presence of minerals of the white metals, such as nickel, cobalt and platinum. The last-named was detected by Mr. William Mallet in the washings from the gold-bearing streams of Wicklow, and in the many analyses which he (Prof. O'Reilly) had made of the Bray Head rocks, nickel and frequently cobalt were found in determinable quantities. Mr. Edward Hardman, in one of his excellent reports, mentioned a hypersthenite of the serpentine-district, which contained from 2 to $2\frac{1}{2}$ per cent. of nickel: a remarkable result, which would have led to further investigation had the fact been discovered in any other country of Europe. It is well established that the mother-rock of platinum is serpentine or hypersthene-rock; and yet, wide as the district of these rocks is in the west of Ireland, it has never occurred to anyone to examine the question, so important both scientifically and industrially at the present moment, by reason

of the many and increasing applications of platinum and the rarity of deposits of the metal.

There are many other questions arising out of Mr. Kinahan's paper, amongst others that affecting the most important "mineral" of Ireland, that is peat: a very vexed question no doubt, but worthy of the most attentive study.

Mr. G. H. Kinahan, replying to the discussion, wrote that Irish coal was not included in his paper. He would, however, mention that it was a rather sweeping assertion to state that "it is so full of pyrites as to be of little value." The Leinster and Munster coals were indeed more or less infested with marcasite; still their market value, on account of their heating powers, was more than double that of Welsh anthracite. Unfortunately, however, the major portion of the profitable seams was exhausted.* The coals of the Connaught and Ulster fields could scarcely be called pyritous, some at least being classed as "sweet coals." It was very questionable whether it would be judicious for any colliery-owners to go to the expense suggested by Mr. Pollok.

The subject of gold in Ireland was very exhaustively dealt with in the papers previously mentioned: it was therefore unnecessary to go over old ground. It was remarkable that the neophytes in the study of mineralogy were so far behind the times; as they seemed to imagine that gold was only to be found in quartz-veins. In county Wicklow, one after another wasted their time with veins long since proved valueless. In this county, it was evident that the gold had some connection with the sulphur-ore lodes; which had been proved to be in some way related to the advent of the newer granite (Upper Devonian or Carboniferous); while colonial engineers who had visited the Goldmine valleys had suggested that the green tufaceous rocks possibly might also be worth examination. In county Wexford as in county Cork, in the Transvaal, in Colorado, etc.—gold should not be as much looked for in the quartz-veins as elsewhere. In connection with Colorado, it might be mentioned that lately (1896) in the wild granite-hills of Cripple Creek, dykes of pitchstone had been discovered carrying at their margins that new and rare mineral calaverite, or telluride of gold. At the

* *Economic Geology of Ireland*, 1889, page 71 *et seq.*, and page 101 *et seq.*

present time, pitchstone had only been recorded in Ireland in the wild granite of Barnesmore, county Donegal; here therefore was a field to which young enthusiasts might turn their attention. Prof. O'Reilly had acted as pioneer in opening up another field for their research, having looked for and found gold in the basic igneous rocks. Prof. Cole did not seem to understand that every particle of gold in a royalty belonged to the tenant of the royalty: and that an unauthorised person who trespassed in covers, disturbing the game, for the purpose of appropriating gold or its ore, was very leniently treated, if he was only turned off the premises when he might have been handed over to the police and brought before a magistrate.

A specimen of chalcocite (copper-glance) from West Cork would be of interest. It seemed remarkable that two minerals so distinct in every way as this and tetrahedrite (grey copper-ore) should be confounded: and that such men as Messrs. Kane, Sullivan, Gage, W. W. Smyth and Wyley, and Cornish miners should have been mistaken. Sir Richard Kane called the mineral by the old nomenclature, subsulphuret of copper; if however, he had believed it to be copper-glance, he would have used the term sulphuret. A hand specimen of copper-glance, said to have been found in the Browhead mine, was exhibited as a great rarity, and it ought to be placed in the museum of the Royal College of Science, Stephen's Green.

The pisolitic iron-ore of Antrim was certainly of secondary formation, and the proofs that this ore was younger than the overlying roof of dolerite would be found in his paper on "The Iron-ore Measures of the County of Antrim."* In the same paper it was also shown that Irish alumite or alum-clay was distinct from ordinary French bauxite and German wocheinite. Irish bole, which was the first clay in Ireland worked for alum, was somewhat similar to bauxite, but yielded a better analysis. Bole was misnamed solely from the insane craze that had bitten young men to use foreign names, in place of those in use for years. This was the case with the bole—Mr. R. G. Norman, as the best authority on the subject, was asked what French alum-clay was called, and its name was immediately adopted. Similarly with the Bann clay, it was quite distinct in character

* *Transactions of the Manchester Geological Society*, 1893, vol. xxii., page 458 *et seq.*

and use from the German diatomaceous clay, yet this outlandish and incorrect German term was that given by an Irish Board in their *Guide to the Cork Exhibition*.

Irish lithomarge was identical with Indian laterite, if we might rely on the specimens sent to this country; in the variation in colour, in their structure and composition, and in the circumstance that both could be cut into bricks that hardened on exposure. The reports of Messrs. William King, Jun., and Robert Bruce Foote, of the Geological Survey of India, on laterite in India are found in their paper on "The Geological Structure of Portions of the Districts of Trichinopoly, Salem and South Arcot, Madras";* and further remarks on the same subject are contained in *A Manual of the Geology of India*,† by Dr. Val Ball. He (Mr. Kinahan) had stated that bright-coloured lithomarges were identical in aspect with some of the varieties of steatitic laterites collected by Mr. A. B. Wynne in Kutch, India."‡

The horizontal iron-ore lodes of county Antrim are of a similar character to the gossan-lode of a standing mineral-vein. In the latter case, the back of the lode, usually iron-ore, contracted away from the standing lode, and the gossan-lode accumulated in the vacancy. In the case of the Antrim lodes, the lithomarge contracted away from the roof leaving a space in which the ore was concentrated. These lodes are similar to standing ones, except that they are horizontal. It may be pointed out that lay-and-lay lodes or lodes between the beds of country-rock are often horizontal.

The serpentine mentioned by Prof. O'Reilly concerned the quarrying industry, and was therefore outside the limits of his (Mr. Kinahan's) paper. Members interested would find in the *Economic Geology of Ireland* lists and descriptions of all the recorded exposures of serpentine (both ophite and ophiolite). The saponaceous rocks, steatite and pyrophyllite, were however included, as they occurred in pockets, dykes and veins, and had in places to be mined. The accumulation at Crohy Head was specially mentioned, as it received the premier place in the *Guide to the Cork Exhibition*, although it was a mere bagatelle

* *Memoirs of the Geological Survey of India*, 1864, vol. iv., page 260.

† Part III., Economic Geology, 1881, page 549.

‡ *Manual of the Geology of Ireland*, 1878, page 163.

to others, such as the tract on Bofin Island, county Mayo: also because the mineral was peculiar in being for the most part laminated. He (Mr. Kinahan), in the *Economic Geology of Ireland*, had temporarily classed it as pyrophyllite, but others, including Prof. Dana, alleged that it was talc (steatite). The laminated variety of pyrophyllite was rather a stumbling-block; as it closely resembled talc in colour, feel, lustre and structure; but under the blow-pipe they acted quite differently, one being a silicate of alumina, and the other a silicate of magnesia.

In the interesting record by Mr. Davies of the exploration now in progress by the Ovoca Copper Syndicate, the "White Ground" was mentioned, but not the "Black or Coal Ground." The latter, however, might prove valuable to work as a bye-product, as Mr. Argall had proved that it contained an appreciable percentage of graphite. Mr. Davies appeared to regret that he (Mr. Kinahan) did not refer to the present endeavours to revive the mining industry. This, however, was a subject that ought to be approached cautiously, because, among other reasons, of free trade, which (as pointed out by Col. Stewart), had handicapped or bled to death Irish mining and most of the other natural Irish industries, including peat-cutting.

The PRESIDENT (Mr. W. O. Wood) moved a vote of thanks to Mr. Kinahan for his interesting paper, and trusted that it would draw attention to the industrial resources of Ireland.

Mr. T. E. FORSTER seconded the resolution, which was cordially approved.

Mr. T. E. PARRINGTON's paper on "The Adoption of a Balance-rope at Hylton Colliery" was read as follows:—

THE ADOPTION OF A BALANCE-ROPE AT HYLTON COLLIERY.

By T. E. PARRINGTON.

It is imperative, where winding has to be done from great depths, that some means should be employed to counteract the effect on the engine of the weight of the winding-ropes. To produce a large output, a high speed of winding is essential: and, to attain this with safety, the load on the engine must be as nearly constant as possible, throughout the run.

The method of applying a tail or balance-rope, hung beneath the cages, though in theory the most perfect, never appears to have come into great favour, especially in this district, owing no doubt to several admitted objections to its use: notably the increased strain on the sockets of the winding-ropes, on the cages, and upon the keps, when the cage is landed; and, in addition, the loop at the pit-bottom has frequently been a source of much trouble, probably owing to the want of some suitable means of guiding it.

The east pit, at Hylton colliery, is 20 feet in diameter, and is drawing coals from the Hutton seam at a depth of 1,560 feet. Some months ago, a balance-rope was introduced into this pit, and it has since been running, most successfully, beneath the cages, specially designed and built for its adoption. Each cage carries eight tubs, that is, four tubs on each deck: the intervening space, in which the men ride, adapts the cage to the double heapstead and obviates "decking." A draw-bar of forged iron, $2\frac{1}{2}$ inches in diameter, runs through the cage from top to bottom. The cage is built in halves, and the draw-bar is inserted before the two sections are bolted together.

Fig. 1 (Plate VII.) represents the cage standing on the keps. At the lift, the draw-bar moves up until the collar, A, comes against the head of the cage, and the cage is taken off the keps and carried on the collar during the run, the draw-bar dropping again so soon as the cage is landed. By this means,

e-rope at Hylton Colliery."

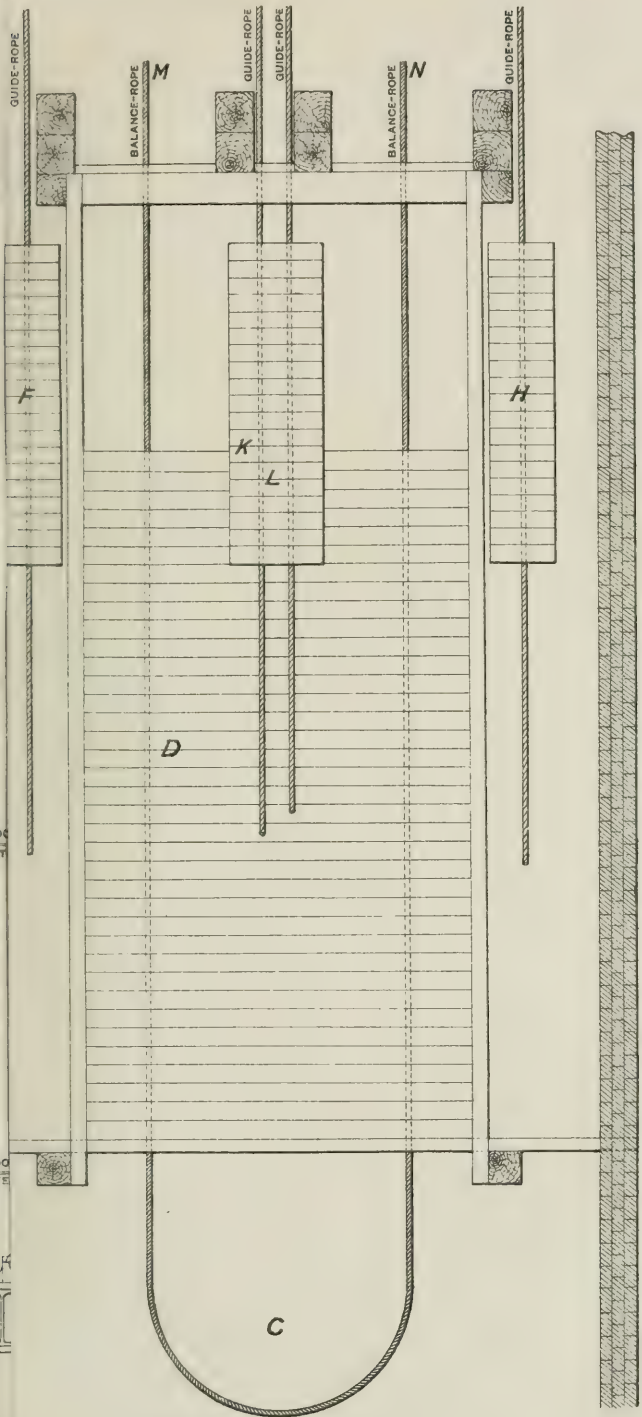

FIG. 3.—CROSS-SECTION.

To illustrate Mr. T. E. Parrington's Paper on "The Adoption of a Balance-rope at Hylton Colliery."

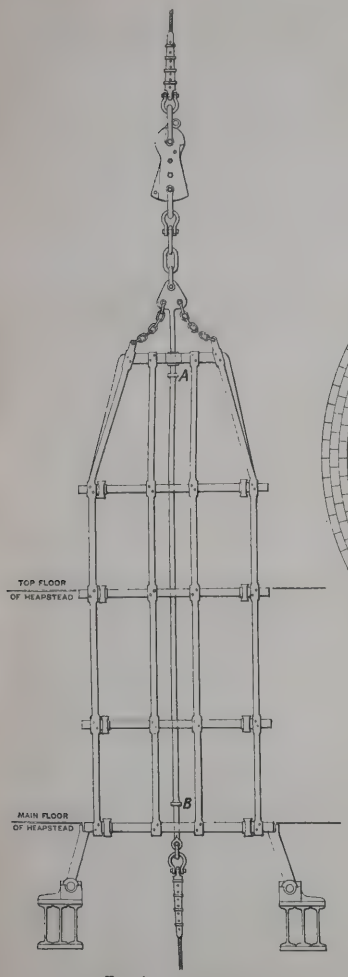

FIG. 1.—ELEVATION.

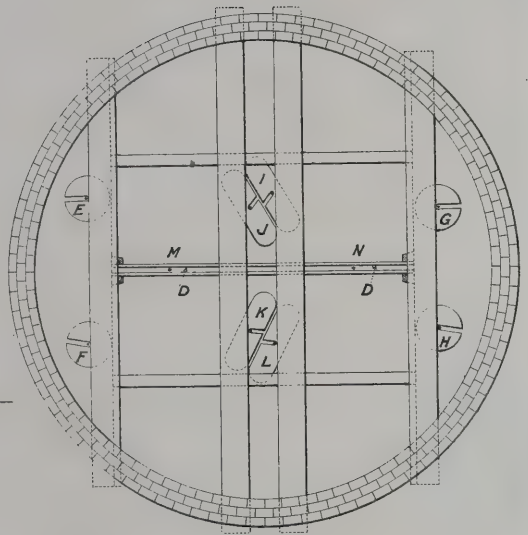

FIG. 2.—PLAN.

Scale, 6 Feet to 1 Inch.

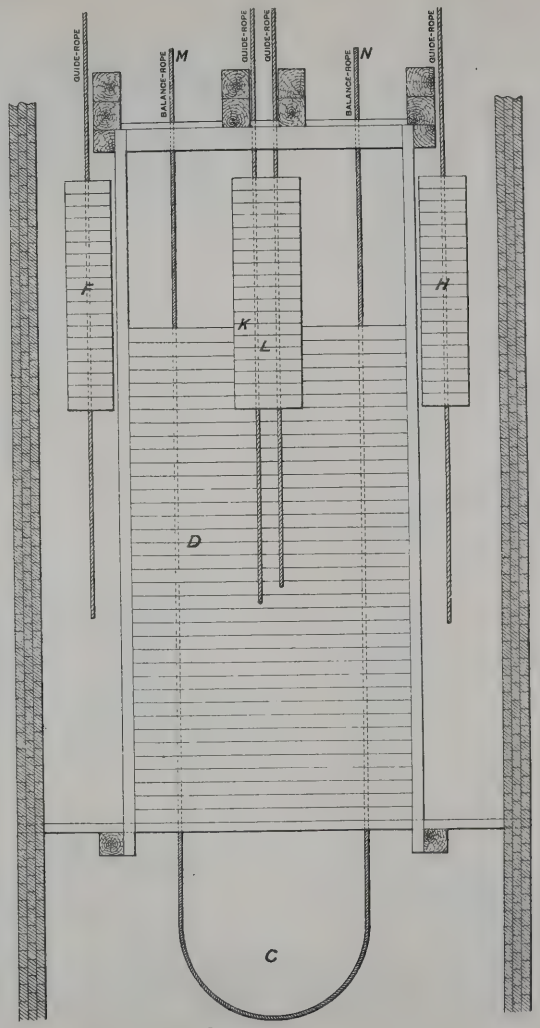

FIG. 3.—CROSS-SECTION.

And.w Reid & Comp.y L.td Newcastle on Tyne

the extra strain occasioned by the weight of the balance-rope is never applied to the cage, while the keps are never required to carry more than the weight of the cage and its load, the balance-rope being always directly connected to the winding-rope by the draw-bar. In the event of the draw-bar falling until the collar, B, rests upon the cage-bottom, the principle would of course fail; but, unless the cage dropped very heavily upon the keps, this could never happen, the movement of the draw-bar being, at the extreme, about 2 inches in ordinary coal-drawing. The winding-ropes and balance-ropes are capped in the ordinary way, the sockets being rivetted and hooped (Fig. 1, Plate VII.). The winding-ropes, of Langs lay, built up of six strands of 17 wires each, are $5\frac{1}{4}$ inches in circumference and weigh 13·7 pounds per yard. In order to make the balance-rope as flexible as possible, special thin wire is used in making it, the full rope comprizing six strands of 37 wires each, and it weighs 12 pounds per yard.

Figs. 2 and 3 (Plate VII.) are a plan and a cross-section respectively of the pit-bottom below the dabbing-baulks; and they show how the loop, C, or return of the balance-rope is dealt with. The rope is made to run in a deep perpendicular groove, D, whose vertical sides guide the rope parallel to the bend, but in all other respects the course of the rope is entirely free. This method, the writer thinks, has not before been adopted in this district, although it has been in use for some years at collieries in South Wales, where he believes it was first introduced.

At Hylton colliery, the groove, D, is 22 feet deep and $2\frac{1}{2}$ inches wide, and the sides are formed of redwood deals, $1\frac{1}{2}$ inches thick. It will be noticed (Fig. 3) that the extreme bend, C, of the rope is allowed to project below the groove, this arrangement being found advisable in order to prevent the possibility of the rope becoming jammed. Owing to the twisting action of the balance-rope, the top deals of the groove, at first, wore through very quickly, but by substituting teak instead of redwood, at the top, the trouble has been overcome. This remedy is preferable to lining the top with sheet-iron, as is sometimes done: the noise in that case being very objectionable. In every other respect the arrangement has been found most satisfactory, and the extreme simplicity is a great recommendation.

Mr. T. E. Forster (Newcastle-upon-Tyne) believed that the first counterbalance-rope on this principle used in Northumberland was introduced at North Seaton colliery about 15 years ago, and it had been running ever since with most satisfactory results. The pit was 860 feet deep. An old-fashioned Murray winding-engine, before the counterbalance-rope was introduced, was raising about 850 tons per day: now as much as 1,300 tons was raised in the same time: and this was sufficient to show that a balance-rope would materially assist an engine rather light for its work. He was surprised that the system of balancing the load had not been more generally adopted in the North of England. At their collieries, 4 or 5 pits were now fitted with counterbalance-ropes: a trough at the pit-bottom was used, and a sheave, placed below the level of the flat-sheets, kept the rope tight. The cages were placed closer together than those described by Mr. Parrington in his paper. There was no arrangement for taking the weight of the cage off the keps, as they had never been used at the shaft-bottom at North Seaton colliery.

Mr. J. B. Atkinson (H.M. Inspector of Mines) said that at the deep pit, Newbattle colliery, and at two or three other pits in Scotland, the rope ran freely without passing round a sheave at the bottom of the pit.

At Kelty colliery, in Fife, where the pit was 1,224 feet deep, a singular accident occurred in connection with a balance-rope. A cage loaded with 4 empty tubs was leaving the surface, when the banksman was overpowered by an empty tub being placed in position to load the same cage in its next descent: and he was thrown into the cage, and the tub was jammed between the top ring of the cage and the flat sheets. The engineman had full steam on the engine to lift the cage at the bottom loaded with 4 full tubs and the movement of this cage tightened the balance-rope and applied power to the bottom of the cage at the surface sufficient to smash the tub holding it, and it eventually fell away. The rope had in the meantime got off the pulley, the distance it fell caused a jerk which broke the chains, and it fell to the bottom of the shaft. To avoid a similar accident in future, the timbers below which the balance-rope extended at the shaft-bottom were so arranged that they

would give way on a slight strain being applied. The winding-engine was worked without a balance-rope for a few weeks, and the output was decreased from 1,400 or 1,500 tons, to 1,000 tons per day.

Mr. W. C. Blackett (Sacriston) stated that he had adopted a similar arrangement for more than 15 years. At first, a chain was hung below the cage, and it gave great satisfaction, until a link of the chain was broken, but nothing serious happened when a chain fell into the shaft-bottom, as it fell dead. In recent years, a flexible rope had been used below the cage, and except on one or two occasions, it had given satisfaction. The rope was run in a deep groove at the shaft-bottom, and the loop was always free to move, if necessary. Many years ago, the subject of counterbalance-ropes was debated by Mr. John Daglish at Silksworth colliery, a very deep pit, and it was a grave question as to how a counterbalance-rope could be safely applied. The question received careful consideration, and it fell to his lot to design a rope tapering at each end from below the cages, so that it might afford an accurate counterbalancing load.

He noticed that, at Hylton colliery, the rope was socketed to the cage by rivets and hoops. Personally, he thought that rivets should never pass through a rope and socket; but there might be cases in which it was necessary. In his own practice, he had abandoned the use of hoops, and now used neither rivets nor hoops: the sockets were absolutely solid, carefully made, and accurately turned.*

Mr. Henry Lawrence (Newcastle-upon-Tyne) said that 45 years ago he applied the same method of counterbalancing to the cages connected with a blast-furnace hoist at Walker, after seeing it in operation at Middlesbrough. A chain was hung underneath each cage, and each chain coiled itself into the pit about a foot below the level of the ground; and it occurred to him that one chain would be sufficient, if it were run round a pulley at the bottom. The great point in this system of counterbalancing the weight of the load was to use a rope under the cage of the same weight as the hoisting rope, and then a perfect counterbalance would be obtained.

* *Trans. Inst. M.E.*, 1901, vol. xxiii., page 10.

Mr. A. L. Steavenson (Durham) remarked, as the counterbalance-rope weighed 12 pounds per yard and the winding-rope 13·7 pounds per yard, the winding-rope was only partially balanced, and the counterbalance-rope did not help the lift from the pit-bottom. He preferred to use a scroll-drum, so as to equalize the load on the winding-engine.

Mr. W. C. Blackett said that by the use of a balance-rope, tapered at each extremity, the same load-line could be obtained as with a scroll-drum.

Mr. John Morison (Cramlington) said that there was considerable novelty in the method of attachment of the cage, and of taking the load of the balance-rope off the keps. The arrangement of the groove for the return of the balance-rope at the pit-bottom might be novel, but he did not think that the groove was necessary, or that any means of guiding the rope was required.

About 9 years ago he had occasion to fit up the deep pit, to which Mr. Atkinson had referred, at Newbattle colliery. He adopted a balance-rope, and only a baulk was placed between the cages, in order that the loop of the rope might not become twisted. If a properly-made, flexible balance-rope was used, he thought that there was no need for any guiding arrangement at the pit-bottom. He could not see how Mr. Blackett's suggested method of using a tapered balance-rope would be better than an ordinary balance-rope.

Mr. W. C. Blackett said that it had been found necessary, at more than one colliery, to provide a smoothly-defined groove, or the equivalent of a groove, by a defined arrangement of timber. In his own experience, he had found that when the balance-rope was running clear, a kind of "gathering" took place, due to the centrifugal force in the return-loop, and eventually the rope was damaged. The balance-rope did not always run plumb, and the use of the groove was a decided improvement, and probably in many cases absolutely necessary.

It was true that with a balance-rope underneath the cages of the same weight as the winding-rope a perfect balance of the load was obtained, but Mr. Steavenson suggested that something more was necessary; and when the winding-engine began

to move, it wanted assistance in starting, just as when stopping it required resistance to bring it quickly to rest. This object was readily attained by using a balance-rope, with extra weight of rope under the cages, produced by tapering the extreme ends of the rope. Thus, when the empty cage was at bank, there was a greater weight of rope hanging underneath the cage than above, and it assisted the winding-engine to start. Also, as the loaded cage moved upward, a portion of the heavy end of the rope, below that cage, began to pass round the loop underneath the ascending cage; and, as it ascended, further portions of that tapered weight were added, until once more the rope was in exact balance during the middle of the winding. Then, as the ascending cage passed still further upward, the other weighted and tapered end began to pass round the loop at the bottom of the shaft and its influence was felt in a corresponding manner.

Mr. John Morison considered that the same object would be obtained by making the balance-rope a little heavier than the winding-rope.

Mr. J. H. Merivale said that he could not understand how the groove prevented the rope from jambing.

Mr. Henry Lawrence said that he recommended the use of a floating pulley, with each of the spindles fitted into a solid bearing similar to the motion-bar of a horizontal engine, these moved up and down in parallel guides, with 5 or 6 feet of play up or down, and thus the rope was always kept in its place by the weight of the pulley.

Prof. Henry Louis said that, so far as he was aware, the draw-bar arrangement of carrying the cage, described in the paper, was quite new. At a colliery in Westphalia, where the Kœpe system of winding was in use, the cage was hung within a bridle; but Mr. Parrington's arrangement was a somewhat different, and, as far as he could see, a better way of attaining the same result.

Mr. H. W. Middleton said that a balance-rope had been in use for 6 or 7 years at Trimdon Grange colliery. At first an old winding-rope was used, but eventually that was taken

out, and a specially-made galvanized rope, weighing 23 pounds to the fathom, was adopted; while the winding-rope weighed only 17 pounds to the fathom. There was no special reason for using that particular weight, and the balance-rope would have been still heavier, if they could have made it so without providing a new winding-rope. The balance-rope had been running both free and with the rope turned round a pulley, and no difference in actual working was experienced.

Mr. J. G. Weeks, in moving a vote of thanks to Mr. Parrington for his paper, said that the writer had not assumed that there was anything new in the use of balance-ropes; but the novelty consisted in the use of a draw-bar, passing through the cage, and carrying the weight of the balance-rope hung below the cage, instead of throwing the strain upon the cage. He thought that the use of a heavier balance-rope than the winding-rope underneath the cages would be of assistance to the winding-engine; but with Mr. Blackett's system of thickening the extreme ends of the balance-rope so as to help the cage away, a deeper place would be required below the bottom of the pit, so that the rope should not be injured in bending and passing round the wheel.

Mr. W. C. Blackett, in seconding the vote of thanks, said that it was not essential that papers must contain novelties, for even old subjects, provided that they were of sufficient interest, could afford useful discussion.

The vote of thanks was cordially adopted.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING,
HELD IN THE WOOD MEMORIAL HALL, NEWCASTLE-UPON-TYNE,
FEBRUARY 13TH, 1904.

MR. W. O. WOOD, PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the last General Meeting, and reported the Proceedings of the Council at their meetings on January 30th and that day.

The following gentlemen were elected, having been previously nominated:—

MEMBERS –

MR. HENRY ARNOLD ABBOTT, H.M. Inspector of Mines, 1, Highbury, West Jesmond, Newcastle-upon-Tyne.

MR. HAROLD VIVIAN ATHRON, Colliery Manager, Hall Lane, Hindley, near Wigan, Lancashire.

MR. FRANCIS BOWMAN, Mechanical Engineer, Ouston Colliery, Chester-le-Street, County Durham.

MR. VINCENT CORBETT, Mining Engineer, Blackett Colliery, Haltwhistle, Northumberland.

MR. JOHN DEAN, Mining Engineer, The Wigan Coal and Iron Company, Limited, Wigan, Lancashire.

MR. ARTHUR STANLEY DOUGLAS, Mining Engineer, Tudhoe House, Tudhoe, near Spennymoor, County Durham.

MR. HAROLD FLETCHER, Mining Engineer, 23, Old Jewry, London, E.C.

Mr. Joseph William Forster, Constructional Engineer, New Kleinfontein Company, P.O., Benoni, Transvaal.

Mr. James Gibson, Surveyor, Assayer, etc., P.O. Box 1026, Johannesburg, Transvaal.

Mr. Howe Hewlett, Mining Engineer, Clock Face Colliery, Sutton Oak, St. Helen's, Lancashire.

Mr. Martin Stanger Higgs, Mine-manager and Consulting Engineer, Southern Main Reef Estates, Limited, Venterskroon, Transvaal.

Mr. Norman Stanley Holliday, Colliery Manager, Acklington Colliery, Amble, Northumberland.

Mr. James Hooper, Mining Engineer, The Poplars, Mount Charles, St. Austell, Cornwall.

Mr. David Howells, Mining Engineer, 12, David Price Street, Aberdare, Glamorganshire.

Mr. John James, Mining Engineer, c/o The Bank of Egypt, Assuan, Upper Egypt.

Mr. Henry Howard Johnson, Mechanical Engineer, The Village Main Reef Gold-mining Company, Limited, P.O. Box 1091, Johannesburg, Transvaal.

Mr. John Evan Jordan, Engineer, 3, Bussey Buildings, Johannesburg, Transvaal.

Mr. Frederick Newbery, Mining Engineer, P.O. Box 1305, Johannesburg, Transvaal; and 230, Camden Road, London, N.W.

Mr. John Ramsay, Colliery Manager, Tursdale Colliery, Ferryhill, County Durham.

Mr. Walker Oswald Tate, Colliery Manager, Shotton Colliery, Castle Eden, R.S.O., County Durham.

Mr. Henry Leigh Trotman, Colliery Manager, Moorland House, Aspull, near Wigan, Lancashire.

Mr. George Herbert Tweddell, Electrical Engineer, 48, Percy Park, Tynemouth, Northumberland.

Associate Members—

Mr. John Eccles Aspinall, Dundee, Natal, South Africa.

Mr. James Russell, Westgate Road, Newcastle-upon-Tyne.

Associates—

Mr. Silas Scrafton Cowley, Deputy-overman, 10, Vane Terrace, New Seaham, *via* Sunderland, County Durham.

Mr. William Simm Rochester, Back-overman, Wellington Terrace, Edmondsley, Chester-le-Street, County Durham.

Mr. Richard Charlton Simpson, Overman, Wellington Terrace, Edmondsley, Chester-le-Street, County Durham.

Mr. Nicholas Stoker, Enginewright, North Walbottle, Newburn, R.S.O., Northumberland.

Mr. Hugh Wilson, Under-manager, 18, Grange Villa, Chester-le-Street, County Durham.

Students—

Mr. Richard Forster Lawson, Mining Student, Daisy Hill, Edmondsley, Chester-le-Street, County Durham.

Mr. Henry Mason Parrington, Mining Student, Hill House, Monkwearmouth, County Durham.

DISCUSSION OF MR. J. B. SIMPSON'S PAPER ON "THE PROBABILITY OF FINDING WORKABLE SEAMS . . . . BELOW THE BROCKWELL SEAM."*

Mr. J. H. Merivale said that a bore-hole had been put down by the owners of Broomhill collieries on Coquet Island, to a depth of about 600 feet below the approximate horizon of the Brockwell seam. So far, two seams, each about 2 feet thick, had been found, and the Mountain Limestone had been reached, but the hole had not reached any of the coal-seams of that series. There was one point of interest to which attention was drawn by the result of the Chopwell boring, and that was the deterioration of the seams to the east. He thought it was generally accepted that the coal-seams in what Mr. Simpson called the "regular Coal-measures" deteriorated to the east, along the coast-line of Northumberland and Durham; and from his own observations they did not deteriorate in a vertical plane, but in one hading to the west, that is, the lower the seams in the series the farther the deterioration extended westward. For 2 or 3 miles along the coast, for example, south of Amble, the upper seams were of good quality up to the shore-line, and then began to deteriorate as they passed eastward under the sea. Whereas, in the lower seams, the deterioration began some distance westward of the shore-line. If this deterioration of the seams, as they approached the sea, continued in the same plane, hading to the west, by the time that the Bernician series was reached the coal-seams would have lost their good quality far inland, and this appeared to be the case at Chopwell. A desire had been expressed that the Coal Commission should give valuable information about the Mountain Limestone seams, but he was inclined to think that any information which Mr. Simpson did not possess, would also be unknown to the Coal Commission. It was an interesting and important problem, and he would like to see some wealthy coal-owners combining together and putting down a bore-hole to a depth of 2,000 or 3,000 feet below the Brockwell seam, and thus solving the question so far as one particular locality was concerned.

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* *Trans. Inst. M.E.*, 1902, vol xxiv., page 549.

DISCUSSION OF MR. WILLIAM CHARLTON'S PAPER ON THE "USE OF RATCHET AND OTHER HAND-MACHINE DRILLS IN THE CLEVELAND MINES."*

Mr. W. Charlton said that the use of ratchet and other hand-machine drills in the Cleveland mines commenced in 1886, and from 0·50 per cent. of the ironstone won by this class of machine in that year, it had increased in 1901 to 39·55 per cent.; in 1902 to 46·92 per cent., and in 1903 to 64 per cent.† It would thus be recognized that in the Cleveland mines, the use of the old jumper-drill had been discarded in favour of power or ratchet-drills. There was a misprint in the last line of a paragraph which should read "power-machines, but by the use of hand-machines."‡

Prof. Henry Louis asked for information as to the date of the introduction of the rotary or ratchet-drill into the North of England generally, as Mr. Charlton gave 1880 as the date of its introduction into the Cleveland district. The earliest dates that he had been able to obtain, so far, were 1869 at Usworth colliery, and about 1872 at Hedley Hill colliery: but he would be glad of more definite information. So far as he could learn, such drills were first devised for use in the Scotch oilshale-fields about 1865: the use seemed to have extended southward about 4 or 5 years later, and they were used for boring in stone before they were tried in coal. It was very curious that in this comparatively brief period they should have so completely supplanted jumper-drills, that it was scarcely possible to find a coal-miner able to use the latter. He had seen a crude rotary drilling-machine, known locally as a "garibaldi," used in the soft-coal region of Pennsylvania, while the stone in the same mine was drilled with a hammer and drill: he thought that this crude machine must have been of independent local invention, and had not been imported.

Mr. T. E. Forster said that hand-machine drills, for boring in coal, were introduced into Northumberland about 1879. They were in use considerably before that date for driving stone-drifts.

* *Trans. Inst. M.E.*, 1902, vol. xxiv., page 526.

† *Ibid.*, page 534.

‡ *Ibid.*, page 537, line 14.

Mr. J. H. Merivale said that at Broomhill collieries, so far as he could remember, hand-drills were used for boring in coal about 1884 and for boring in stone, about three years later.

Mr. T. E. Forster asked whether the rotary drill had ever been used in Cleveland for boring in any stone harder than ironstone.

Mr. W. Charlton stated that Cleveland ironstone was much harder than coal, and a ratchet-machine could drill through the "dogger-band" in the ironstone, although it was much harder.

Mr. C. H. Steavenson said that he had had experience with ratchet drilling-machines in Cleveland mines: so when he came to Tyneside he brought a ratchet-drill with him, and had it tried in both stone and coal, but he was sorry to say that it was not successful. The fixing of the machine was difficult where the post-stone was too hard to drive in a wedge for the purpose of attaching the machine. In the case of ironstone, the wedge was driven into the rock at the side, and the end of the machine was fixed against this wedge. A hole was made for the entrance of the drill, and when the man started to work the ratchet the pressure kept the drill in position. In the post-stone of North of England collieries he found that the wedge could not be driven in far enough to make a sufficiently strong support for the machine, and in the case of blue metal or shale, the stone was too soft. Altogether he found that the ratchet drilling-machine was not so successful as the ordinary stone-man's or hewer's hand drilling-machine.

Mr. W. Charlton said that his paper showed the great advantage of the Cleveland method of fixing hand drilling-machines, and how that advantage had promoted their use in the ironstone-mines. Where that method could not be adopted, they could adopt the old-fashioned method of making a prop serve as a support for the machine.

Mr. William Severs said that, at one of his collieries, a drift, 12 feet wide by 6 feet high, was being driven with ratchet-machines, and a prop was used as a support for the machine. Hand-drilling cost £10 per yard, but with ratchet-machines the cost was reduced to £7 per yard.

Mr. C. H. Steavenson said that his remarks referred to the type of drilling-machine used in Cleveland. Ratchet-machines were in use on Tyneside, but they were of a different type from the drills used in Cleveland.

The President (Mr. W. O. Wood) said that drilling-machines were introduced into the collieries of the North of England about 1872, and they were now universally used. It was rare to see a man using a hammer and drill, or even a jumper. At his own collieries, no difficulty was found in fixing the machine as Mr. Steavenson seemed to indicate: sometime props were used, and at other times, a proper stand.

Mr. William Severs remarked that the men used the machine with a stand at first; but now it was discarded altogether, and a prop was used.

Mr. F. I. Leslie Ditmas wrote that the displacement of the old method of jumping in the holes, naturally showed the advance that the Cleveland district had made in the reduction of the working costs of the mines, and the gradual evolution of man-power to that of man-and-machine-power, which was in its turn giving place to that of power-machines, driven by compressed air or electricity.

At one of the Rosedale mines, practically all the drilling was done by an electric drill, which differed in many respects from the other electric drills in use in Cleveland. It was found, when using electrically-driven drills, that a certain percentage of holes must of necessity be bored which were quite useless (this was a matter of slight moment, as the holes were drilled so rapidly) and which hand-machines would avoid, as, in this latter case, firing took place immediately after each hole was put in, and the next hole could be placed in the most advantageous position.

With hand-drills, the ratchet and Elliott machine-stand were used, but there were still a number of the older miners, who liked to be supplied with jumper-drills in addition. They argued and in most cases rightly, that for certain positions (especially in removing the pillars), it was an easier and a faster method to jump the holes, than to fix the Elliott telescopic machine-frame in a place 9 or 10 feet high, if the timbering were not quite

suitable, and only a "pop-hole" was required. The physical labour involved in jumping a hole was greater, and more time was required than when it was drilled by a machine; and it was simply a matter of time when jumpers would cease to exist, except for occasional and exceptional conditions. The younger miners, now, hardly knew how to obtain the best results from using the jumper-drill, nor did they care to learn how to use it. Of course, the power-drill (electric-driven for preference) would in time displace the best hand-machine drills used in most ironstone-mines.

DISCUSSION OF MR. C. C. LEACH'S PAPER ON "SUPERHEATED STEAM AT SEGHILL COLLIERY."*

Mr. C. C. Leach said that he had carried out some further experiments to ascertain the loss of steam in steam-pipes. The experiments were made on a Sunday, when all the engines were stopped, except the donkey-pump, which fed the boilers. The test was continued from 7 a.m. to 5 p.m., the boiler-pressure was maintained to 80 pounds per square inch, and no steam was blown off. The temperature of the air was 57·8° Fahr. He found that 2,450 pounds of water per hour went into the boilers. Of this weight, the donkey-pump used for pumping the water into the boilers consumed 49 pounds, and 608 pounds were caught at leaks and steam-traps, leaving 1,793 pounds per hour to be accounted for. The coal burned per hour was 240 pounds, and this showed a loss of 9·6 per cent. on the ordinary day's coal-work. The area of the surface of the pipes, beneath the covering, was 3,036 square feet.

Mr. W. C. Blackett asked whether much water was found standing in the cylinders.

Mr. C. C. Leach said that he had no idea, but steam was passing through the cylinder of the big winding-engine, as it felt warm to the touch of the hand.

Mr. J. H. Merivale said that these experiments were exceedingly interesting, but before the members could form a definite idea they would require considerably more information. The loss of water seemed enormous, if all the engines were

* *Trans. Inst. M.E.*, 1902, vol. xxiv., page 538.

placed near the boilers: but if some of them were placed underground and some distance inbye from the shaft-bottom, a very different construction would be put upon it. A loss of 10 per cent. of the quantity of water used was, after all, not so very high a figure: and with every engine going at full work the loss would probably not exceed 2 or 3 per cent.

Mr. C. C. Leach said that the loss of 9·6 per cent. referred to full work. The distance from the engines to the boilers varied from 46 feet to 618 feet, and there were no engines in the mine. The most important matter was the number of square feet exposed to the air, and this depended on the length of pipes, and their outside diameter. No doubt a great deal of steam was wasting through the two old-fashioned engines, but wherever a drop of water could be detected, a bucket was placed to catch it.

Mr. W. C. Blackett said that it might console Mr. Leach for the very great trouble that he had taken over his paper to know that one of the fruits of his missionary-work had been to induce him (Mr. Blackett) to go more closely into the question, and to make experiments in the same direction. At one of his collieries, where the boilers were fired by the waste-gases from the coke-ovens, and were capable of producing pressures much greater than some of the other boilers, it occurred to him that if he could confine all the steam in the boilers capable of working at a high pressure, and not allow it to be used until it attained that pressure, he would get a superheated action on the low-pressure pipes when it was allowed to go through them. He accordingly put in a valve, which would not allow the steam to pass through it, until the correct pressure was attained. The use of this valve had an excellent effect: the superheat in the high-pressure steam became available: and, when it passed into the low-pressure pipes, the steam was dried, and there was a notable economy of fuel.

Mr. C. C. Leach said that one of the most remarkable matters in connection with the superheat in steam was the manner in which it disappeared before reaching the engine. In the experiments referred to, the steam entering the pipes was superheated by 150° or 200° Fahr.

Mr. Henry Lawrence said that many years ago he had charge of works using superheated steam, but he could not arrive at any saving, because he was firing with blast-furnace gases. There were 6 boilers in a row, one of which was held in reserve. He used the spare boiler as a superheater, and passed all the ordinary steam out of the various boilers into the superheater before it went away to the blast-engines. A very high amount of superheat, from 700° to 750° Fahr. was attained: it was sometimes stopped, when it rose too high, and the steam began to arrive at the engine with a temperature sufficient to injure the packing. There was a safety-valve on the superheater, and when steam was blowing off no vapour could be seen coming out of the safety-valve—it was almost colourless. The steam was very dry, and a hand could be passed through the vapour coming from the safety-valve on the superheater without being scalded, on account of there being no moisture in the steam. Judging from the temperature at the engines, he gathered that the superheat was much less, and that saturated steam and not dry steam arrived at many of the engines. He asked whether Mr. Leach had ascertained the temperature of the gases at the bottom of the chimney from the boilers when producing ordinary saturated steam, and the lower temperature of the gases after they had been passed through the superheater.

Mr. C. C. Leach said that he did not notice any particular appearance when steam was blowing off at the safety-valve upon the superheater. The steam, however, was absolutely superheated, as it had not time to lose it. The temperature of the flue-gases must be greater at the superheater than at the chimney; and they would probably lose about 500° Fahr. when they reached the chimney-bottom. The temperature ranged from 1,000° to 1,100° Fahr. at the superheater, and the diagram (Fig. 3, Plate XVI.)* shewed that there were considerable variations.

The President said that it appeared that Mr. Leach put 2,450 pounds of water into the boilers, and a very large proportion was lost. The solution of the mystery would no doubt provide occupation for some little time to come.

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* *Trans. Inst. M.E.*, 1902, vol. xxiv., page 542.

DISCUSSION OF MR. W. H. BORLASE'S "DESCRIPTION OF THE LEAD-ORE WASHING-PLANT AT THE GREENSIDE MINES, PATTERDALE."*

Mr. ARTHUR E. NORTHEY (Talybont, R.S.O., Cardiganshire) wrote asking for the following information:—(1) What are the dimensions of the rough ore-stuff when it leaves the stone-breaker (Fig. 2, Plate XIII.†)?; (2) how many tons of ore-stuff are treated by the first three sets of crusher-rolls per hour, or, per day of 10 hours?; (3) what is the speed of the crusher-rolls?; and (4) what is the daily approximate finished output for the total labour-cost of 10s. 6d. per ton: that is, what is the daily finished output of the dressing-plant, when treating crude stuff containing 7 per cent. of lead-ore?

Mr. W. H. BORLASE (Glenridding, near Penrith), wrote that:—(1) The stuff was broken by the stone-breaker to about $1\frac{1}{2}$ inches cube. (2) The tonnage varied according to the stuff supplied, and whether or not it had passed through the stone-breaker, from 40 to 50 tons per day of 10 hours. (3) The speed of the fluted rolls was 8 revolutions per minute, and of the plain rolls, 16 revolutions per minute. And (4) about 6 tons of dressed ore were produced daily. It must be understood that the crude stuff contained 7 per cent. of lead-ore, and this was relieved at the picking grates of much gangue and waste, making the stuff, supplied to the crushers, probably contain about 15 per cent. of lead-ore.

DISCUSSION OF MR. T. ADAMSON'S PAPER ON "WORKING A THICK COAL-SEAM IN BENGAL, INDIA."‡

Prof. HENRY LOUIS said that, on comparing the method described in the paper with other methods in use in India, although the former was not particularly safe, it would be difficult to suggest anything better. In all the coal-fields of India, coal was being wrought at an extraordinarily cheap rate. Hewing only cost 7d. per ton in some places, and the selling-price of coal at the pit was only 1s. 6d. to 2s. 6d. per ton. People who were mining coal systematically had to face competition from the native coal-owners who worked the outcrops of coal-seams,

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 331. † *Ibid.*, page 338.

‡ *Ibid.*, 1903, vol. xxv., pages 10, 192 and 396; and vol. xxvi., page 19.

in some cases 25 to 30 feet thick, taking out what they could and leaving the rest to be crushed in the small pillars that were left, the method of working being at the same time very unsafe. Even other methods of working the mines were not always what one would desire, and in one instance he knew of a manager, who made his pillars of pyramidal form, tapering upwards, because he said that was the safest shape to make a pillar. Were it not for a special providence in the shape of a splendid roof, accidents in the Indian coal-fields would be numerous. He (Prof. Louis) condemned the practice in the author's collieries of blasting with dynamite in the large chambers; the coal made a lot of dust, and he thought that they might easily adopt a safer explosive. He could not suggest any better method of working, under the circumstances, and he thought that much might be urged in mitigation of the criticism which had been passed on the method of working described in Mr. Adamson's paper.

Mr. J. B. Atkinson (H.M. Inspector of Mines) said that at a previous meeting he had agreed with Mr. Steavenson that the method described in the paper seemed to be a somewhat dangerous one. The conditions prevailing, particularly the want of timber, perhaps made it the only possible way of working; but as regards the danger, that might possibly be decided by statistics.

DISCUSSION OF DR. J. S. HALDANE'S PAPER ON "MINERS' ANÆMIA, OR ANKYLOSTOMIASIS."*

Mr. W. C. Blackett said that it occurred to him that ankylostomiasis was being rather lightly treated in this part of the country at the present time. From a recent remark that Dr. Haldane had added to one of his publications, it seemed that the mines were not in so secure a position as many thought they might be. Many managers had taken comfort from the fact that the worm did not develop, except at a temperature of about 68° Fahr.; but Dr. Haldane had pointed out that further observations tended to show that the larvæ had developed at considerably lower temperatures. If that was the case, it seemed to him that they wanted to pay a little more regard to the subject

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 643.

than they had been doing. Although the temperature of many of the mines did not reach 68° Fahr., there were some where it did: and it should be borne in mind that many mines which naturally reached that temperature were "dry and dusty mines," and were being, at the present time, carefully watered in many parts for the purpose of laying the dust, and the water would produce conditions favourable to the development of the larvæ.

He (Mr. Blackett) was of opinion that the best way to deal with the threatened invasion of the disease was to show the miners, by lectures illustrated with lantern-slides, the nature of, and the remedy for, the parasite, and leave, very largely to their good sense, the methods by which the fouling of the mine could be avoided. Doubtless there would be among them selfish and irresponsible persons who, careless of the general welfare, would take little trouble in the matter: but these men could be dealt with in the course of time; and at any rate the effort would serve to draw attention and constitute a beginning for what might be a better state of things in future.

He (Mr. Blackett) further suggested that such earth-closets as were constructed at the pit-bottoms, etc., could be made to use up some of the dust of the mine, and this would "kill two birds with one stone."

Another interesting point that occurred to him in connection with the medical part of the report was this: Dr. Haldane had stated that the *Strongylus* or *Ankylostoma* only invaded the small intestine. Had he (Mr. Blackett) been in a position to question Dr. Haldane, he would have said that there was considerable doubt about this, because it seemed to him that the *Strongylus* which attacked the human being was almost identical with that which invaded the horse. They each produced exactly the same condition: there was the same anæmia, the same paleness, as could be seen in the eyelids and nostrils in the horse, which became incapable of work and listless, lost its healthy appearance of coat, and, in fact, became exactly as had been described in the report referring to man. He also found that practically similar remedies were used for the horse as for the human subject. The new remedy which had been tried in the Cockerill Hospital, "terpine," was the essential part of turpentine: the remedy given to the horse was a repeated dose of turpentine and oil, with sometimes a little opium to kill the

pain. The same remedies were, therefore, given in both cases to get rid of the worm from the mucous membrane, after which other medicines were given, such as iron, etc., for a tonic. In the case of the horse, one judged from its appearance whether the worms had been got rid of, but one could never be quite sure. The symptoms and treatment were, therefore, almost identical. With respect to the small intestine, he (Mr. Blackett) had seen horses cut open, and had been present at *post-mortem* examinations, and in one very bad case—which he thought possible to be paralleled in man—he had seen the worm distributed throughout the intestines, and even within the mesenteric artery itself. It therefore seemed to him a pity to jump to the conclusion that the worm, in man, would only infest the small intestine.

Mr. C. C. Leach said that in one of the return-airways at Seghill colliery the temperature was steady at only 57° Fahr., and therefore he thought that such a mine had not the slightest chance of propagating the disease. The only place in which any person was liable to contamination was in the intake-airways, these were very much cooler than the return airways, and fatal to the worm if ever it got there.

Mr. J. B. Atkinson (H.M. Inspector of Mines) said that there were a number of deep collieries in the county of Durham where the temperature of the working-face was higher than 70° Fahr.; but they were almost always in such a condition of dryness that probably the worm would not develop. He had recently received a communication from the Home Office stating that at 61° Fahr. the worm might be developed. He should think that temperature was frequently exceeded in Durham mines; but perhaps not so often in Northumberland.

Mr. J. H. Merivale said that at the Broomhill collieries the temperature was lower than that which would propagate the worm. At the same time, he thought that they were the only collieries in this district which provided conveniences for the men belowground, and he had done so before this disease was heard of.

Mr. T. E. Forster asked how many conveniences were provided and how many men were employed.

Mr. C. H. Merivale stated that only four conveniences were provided, and that shifters had the task of cleaning them.

Mr. J. H. Nicholson said that it had been shewn that the principal danger arose from the employment of foreign workmen. He understood that Italian miners had been introduced into the lead-mines of the Alston district. The conditions in metalliferous mines were more likely to develop the worm than those of coal-mines, and Italian workmen, perhaps drafted from some of the large tunnels on the Continent, were very probable "worm-carriers." He suggested that it would be wise to keep such men under observation, until it was proved that they were free from the disease.

The President (Mr. W. O. Wood) said that not a single case of the disease had been discovered in the counties of Durham and Northumberland. It had been observed in Cornwall, where the conditions were exceedingly favourable to its propagation, but the interest in this district arose rather from an academical or physiological point of view. Although the roads were watered, the working-places were exceedingly dry, and it was impossible for any worm to flourish there.

Mr. M. Walton Brown suggested that the people, who especially required watching are the Poles, not only on account of ankylostomiasis, but also on account of the especially virulent form of *tænia* to which the Polish race is subject. It was also important that earth-closets should be provided for the use of the workmen, in preference to any other form of closet. He also suggested that the eggs would be destroyed by mine-waters, containing, say, chlorides of sodium and calcium, salts of iron, free sulphuric acid, etc.

Mr. J. C. B. Hendy believed that it was a medical axiom that, if a person who was at all sensitive thought very much about a certain disease, he was more liable to contract it than he would otherwise be. He thought that if they debated this question for any length of time rumours of it might reach the coal-hewers, and they might begin to think too much about it and so induce the disease in that way.

Mr. J. B. Atkinson (H.M. Inspector of Mines) understood that the miners were considering the disease, and as they found

the name difficult to pronounce it had acquired a new appellation, namely, "Hanky-panky."

Dr. J. S. Haldane wrote that, with regard to the important question of temperature raised by Mr. Blackett and other speakers, he had relied on Westphalian colliery-statistics and German laboratory-experiments for the statement in his paper that the development of the infective stage of the larva probably required a temperature of over 70° Fahr. Since then, however, Dr. Boycott and he had re-investigated the question, and found that if sufficient time were given (3 or 4 weeks) a temperature of 61° Fahr. was quite sufficient.* It appeared also from a table given by Dr. Barbier, at the end of a paper read by him before Section IV. of the International Congress of Hygiene, Brussels, 1903, that a number of collieries in the Liége district had been infected very seriously, although their temperatures at the working-face were well below 70° Fahr., and even as low as 60° Fahr. in one or two cases. Probably, however, the infection spread much more rapidly in warm and damp collieries, and this might be the reason why the cooler and shallower pits had hitherto escaped in Westphalia.

He (Dr. Haldane) agreed that particular care should be taken when Italian miners were employed, as in some parts of Italy about half of the population seemed to be slightly infected; but Cornish miners, and English miners returning from tropical countries, might also introduce infection. He did not think that any danger from tape-worm infection could arise in mines, as the tape-worm required an intermediate host, such as an ox, sheep or pig for its development to the infective stage, and the infection was carried by uncooked meat from one of these animals.

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* "Ankylostomiasis," No. II., by Drs. A. E. Boycott and J. S. Haldane, *The Journal of Hygiene*, 1904, vol. iv., page 82.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING,

HELD IN THE WOOD MEMORIAL HALL, NEWCASTLE-UPON-TYNE,
APRIL 9TH, 1904.

MR. W. O. WOOD, PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on March 26th and that day.

The following gentlemen were elected, having been previously nominated:—

MEMBERS—

MR. JOHN BIBBY, Mine-manager, Harrietville, Victoria, Australia.

MR. HENRY MAITHEWS BULL, Manager, Bengal Coal Company, Limited, Rayhara, East Indian Railway, Palaman District, India.

MR. CECIL AUGUST ESMARCH, Electrical Engineer, 13, Westgate Road, Newcastle-upon-Tyne.

MR. STENER AUGUST FANGEN, Mining Engineer, Kroken, No. 7, Bergen, Norway.

MR. GATHORNE JOHN FISHER, Civil and Mining Engineer, Club Chambers, Pontypool, Monmouthshire.

MR. EDWARD GRIBBEN, Mine-manager, Harrietville, Victoria, Australia.

MR. THOMAS GRIFFITH, Agent and Director, Maes Gwyn, Cymmer, Porth, near Pontypridd, Glamorganshire.

MR. WILLIAM WALKER HOOD, Mining Engineer, Glyncornel, Llwynypia, Glamorganshire.

MR. RIENZI WALTON MACFARLANE, Mining Engineer, c/o Col. S. Beckett, 10, Treeland Road, Ealing, London, W.

MR. ROBERT MCINTOSH, Assistant Inspector of Mines, Dunedin, New Zealand.

MR. EDWARD DAVID MILES, Mining Engineer and Mine Superintendent, Charters Towers, Queensland, Australia.

MR. THOMAS THOMSON RANKIN, Principal of the Mining and Technical College, Wigan.

MR. PAUL SCHWARZ, Coke-oven Engineer, 4, South Avenue, Ryton-upon-Tyne.

MR. PETER B. STEVINSON, Engineer, 4, Warwick Street, Heaton, Newcastle-upon-Tyne.

MR. JAMES STEWART, Colliery Engineer, Garesfield Colliery, Rowlands Gill, Newcastle-upon-Tyne.

Mr. William Stewart, Colliery Manager, Milnthorp House, Sandal, Wakefield.

Mr. Alfred Simeon Tallis, Mining Engineer, The Rhyd, Tredegar, Monmouthshire.

Mr. Otto Witt, Engineer, Director of Altens Kobbergruber, Kaafjord, Finnmarken, Norway.

Associate Member—

Mr. Raymond William Schumacher, P.O. Box 149, Johannesburg, Transvaal.

Associates—

Mr. Thomas Burt, Overman, Engine Square, Washington Colliery, County Durham.

Mr. John Cockburn, Under-manager, Fatfield Road, Washington, County Durham.

Mr. John Joseph Marshall, Back-overman, 14, Fairford Terrace, Stanley, R.S.O., County Durham.

Mr. William Edward Swan, Mechanical Engineer, Washington Colliery, County Durham.

Subscriber—

Messrs. Mavor & Coulson, Limited, Electrical Engineers, 47, Broad Street, Mile-end, Glasgow.

DISCUSSION OF MR. J. M. MACLAREN'S PAPER ON "THE OCCURRENCE OF GOLD IN GREAT BRITAIN AND IRELAND."*

Mr. R. McLaren (H.M. Inspector of Mines) wrote that Mr. Maclaren's paper was a valuable contribution to the *Transactions*, and as part of it related to the East of Scotland mines-inspection district, he would offer a few observations.

The writer states that "the gold of the Leadhills area is found in the streams, into which it has been washed from a gravelly clay, locally known as 'till,' which lies disposed on the slopes of the hills,"† and while this is so, it is perhaps of more importance to know that, in all the veins where galena has been discovered, gold has also been found. In all, 25 veins have been worked more or less in the area, and metal has been found in most. At the present time, there are two principal veins worked for lead-ore: the workings on the Brown vein have attained a depth of 1,320 feet, and on the Brow vein, to about half that depth. An analysis of the ore recently gave, in addition to a

* *Trans. Inst. M.E.*, 1902, vol. xxv., page 435.

† *Ibid.*, page 469.

large percentage of lead, about 4 ounces of silver. On the Lowther hills, traces of gold were found in stone, and a mine for prospecting was driven; but, failing to find either gold or lead, it was abandoned. It is the opinion of experts in the district, founded on close observation, that gold is to be found on the outcrop or "top" of the lead-veins, and that the gold is washed off and carried to the streams, where it is deposited. All the streams in the district have at some time yielded fine gold. The veins now being worked yield no trace of gold, which indicates that as depth is attained the gold-content disappears.

In many respects, Sutherland resembles Leadhills, both being in the same geological formation. Gold is found in the streams, and it is apparently brought from the surrounding hills. If further search was made it would probably be found that the gold was produced from the outcrop of some mineral-veins. These veins, like those in Leadhills, may consist of lead-ore, and quite possibly of sufficient richness to be payable. It does not appear that any special effort has been made to thoroughly prospect the hills near Kildonan and Gordon-bush to ascertain what, if any, minerals they contain.

Mr. H. M. Cadell wrote that the occurrence of gold in Scotland and especially among the crystalline schists of the Highlands, had frequently been an interesting subject of discussion, and like others who had visited gold-bearing countries he (Mr. Cadell) had often prospected on a small scale at home, where rocks are found similar to those of our colonial gold-fields. If no gold-bearing reefs had been discovered in the Highlands it was not because they had not been looked for, and, he (Mr. Cadell) feared that the prospects of success in this direction were not promising. He was well acquainted with the Kildonan "gold-field" and had washed small nuggets from the gravel there as an amusement, but as a matter of business he would say "Don't" to anyone bent on further digging at the Bail n'Oir. One reason why the Scottish glens were not likely to contain much auriferous alluvium was this:—During the Glacial Period the whole country was scoured clean, and all the rotted rock which might have contained the oxidized caps of gold-veins, as well as all the ancient Tertiary alluvial deposit in the valleys, was swept away by the vast ice-sheets

and glaciers, under which the country was deeply buried for many thousands of years. When the ice retreated it left the land for the most part plastered over with a mass of drift or boulder-clay, made up of rocks, soil and detritus, squeezed and mixed together tumultuously and without any relation to the specific gravities of the respective constituent materials. If therefore any gold was derived from the ground-up rocks in the boulder-clay, it must have been finely disseminated through the mass, and could not be profitably separated from it. Since the Glacial Period, the streams and rivers had been busy washing away the Glacial deposits and, to some extent, re-arranging them in the valleys, according to their size and weight. There had, however, not yet elapsed nearly enough time for all the Glacial drift to be thus washed down, sifted out and turned into alluvium, and therefore it was useless even to expect to find any very extensive alluvial gold-deposits north of the Tweed. No doubt gold occurred in Scotland as well as in other countries, but for some unknown geological reason all the evidence hitherto tended to prove that it was too finely disseminated to be worth working on a practical scale. He (Mr. Cadell) thought that Mr. Maclaren's paper contained an interesting and useful summary of our knowledge of an attractive subject, but at present the interest seemed rather of an academic and historical than of a practical nature.

Mr. J. T. Robson (H.M. Inspector of Mines, Swansea) wrote that since the period referred to by Mr. Maclaren (1889 to 1891), when the Ogofau gold-mine was worked by the South Wales Gold-mining Company, one more attempt had been made to work the mine. This was in 1898, but the attempt was soon given up; and in the early part of the following year there was no one at the mine, except a caretaker. No return of mineral was made, and, probably, no gold was obtained from the small quantity of quartz worked during 1898. Since then, he had not heard of any further attempt being made to work the mine. The Ogofau mine was the only one in South Wales from which gold had been obtained during the past 17 years.

Prof. Grenville A. J. Cole (Royal College of Science for Ireland, Dublin) wrote that, considering the occurrence of gold

in geyser-pipes and in peridotites, rocks that were presumably of deep-seated origin, he suspected that its presence in quartz-veins in British rocks indicated a deeper source than the immediately-surrounding country.

The nomenclature of the Silurian strata differed in Plates XVII. and XIX.; in the former it was that of the older Cambridge school, and in the latter that peculiar to Prof. E. Hull. The rocks of Rhobell-fawr (Plate XVII.) shown as of Bala age, were once classed as of Arenig age, but they were now known to lie on a Tremadoc horizon.

Mr. G. H. Kinahan (Dublin) wrote that Mr. Maclaren ignored the northern portion of the Gold-mine valley district (Plate VI.); that was the area drained by the northern tributaries of the Darragh water or Aughrim river, the Macreddin stream and the Ow. The first stream was successfully worked for gold, by streaming in its head-waters, while there was a length of over 3 miles of untried deep diluvium between the workings and its junction with the Darragh water. In the gravel of the Ow, gold had been proved; while there was most successful streaming in its tributary, the Mucklagh brook. Mr. F. Acheson, after he had prospected the East Wicklow gold-field, considered from his previous Australian experience that the Ow valley was the best place to begin his adventure. He therefore diverted the Ow stream into the Roddenagh wood, by making a dam and a canal. He then, on the colonial system, in the lot laid out, had all the overbaring above the "pay-dirt" removed, intending to make one washing of the auriferous black sand. The fates, however, were against him: he had everything prepared to begin washing, when a "plump" or water-spout fell on Lugnaquillia, thus forming a spate in the river Ow, that broke down the dam and obliterated the working. From the Mucklagh brook to the Darragh water there were 6 miles of the bed of the Ow left unworked. Mr. Acheson subsequently did more prospecting than actual mining: he sank a shaft on a green tuffose bed that was similar in appearance to some of the Australian gold-bearers. Here again, the fates were against him, as a plump fell on Croghan Kinshelagh that flooded the pit. About this time, Mr. Acheson had perfected a theory, on the same principle as that followed by gold-seekers in Brazil,

in connection with the leads, which he calculated ought to join and bunch: to find this bonanza, he devoted his exploratory efforts. Consequently he did very little at legitimate streaming.

It was a mistake to believe that Mr. Thomas Weaver stopped his works down stream, because the overbaring became heavy, and the leads poor. He and his colleagues were ordered to take away all gold down to a limited depth, so that the natives could not get it: and none of his workings were more than 12 or 15 feet deep. He went down the Coolbawn stream until the overbaring became heavy: then he began below where the drift-head was light, and worked up stream, till he stopped for a similar reason, leaving betweeen the two workings about ⅔ miles of unworked ground. In the Gold-mine river, about ¼ mile below and north-east of Ballinasilloge ford, there were two leads, that to the south-east being shallow and the other deep. Mr. Weaver followed the first, leaving the second to be partially worked by the Crockford and Carysfort Mining Companies, and it was here that Mr. Crockford lifted a nugget weighing 11 ounces. Between the lowest works on this stream there was over 1 mile of deep ground before it joined the Darragh water. From the already mentioned Coolbawn stream to the river Ovoca, at Woodenbridge, there were over 7 miles of unworked ground of the Darragh water, although at Ballycoogsteps and Ballintemple auriferous gravel had been proved: there should also be "dry gulches" and "shelf"-placers.* While these remained unexplored, it seemed rash to state that the gold of East Wicklow was probably exhausted.

The mines of the Ovoca valley, also, should not be overlooked. To the east of the river were the auriferous lodes at Kilmacoo and Connary, that drain into the Ovoca by the Shroughmore burn: next to them were the Magpie and Yellow Bottom mines of Eastern Cronebane, both also auriferous. Farther west were West Cronebane and Tigroney: in these, also in Ballygahin and Ballymurtagh, to the west of the Ovoca, the main or south lodes had long since lost their backs and gossans by denudation: these, it might be suggested, were

* "The Possibility of Gold being found in County Wicklow," by Mr. G. H. Kinahan, *Scientific Proceedings of the Royal Dublin Society*, 1883, new series, vol. iv., page 39.

more or less auriferous because the Ballymurtagh lode was in part at least so. Where did the denuded portions go? Probably southward with the ice; and partly to form the present diluvium in the Ovoca valley. We therefore had this detritus and the drainage of the mines to generate gold in a river-bed over 8 miles long, from Shroughmore to the sea. Gold had already been found a short distance south of the Ovoca railway-station, in the gravel of the reach left dry, when the river was diverted during the construction of the Dublin, Wicklow and Wexford railway. Here it might be suggested that this now dry portion of the old river-bed seemed a legitimate field for a syndicate to spend a few hundred pounds in exploration-work.

As to the genesis of the gold, in the Gold-mine valley district, it appeared nearly impossible that it could have come from the East and West Ovoca mines; and he (Mr. Kinahan) would look for the sources nearer afield.

In his (Mr. Kinahan's) paper, just now referred to, it was suggested that if the gold of the Gold-mine valley had an existing "mother-rock" or reef, it ought to be found somewhere near the upward limits of the gold in each stream; that was, in Ballinasilloge to the north-west, and Knockmiller, Monaglogh, and Mongan to the south-east. It however, seemed improbable that the source was in a reef, especially a quartz-vein; although the startling statement had recently been made, that a quartz-vein had been found that returned 8 ounces of gold to the ton. Such a statement must be received with great caution, as the vein was said to be in a most conspicuous place, that was, at the mouth of Mr. Weaver's tunnel. Now Mr. Weaver and his colleagues, also Mr. Mallet, the agents of the Carysfort and Crockford Mining Companies, and various other men of experience, had carefully examined all the quartz of the valley and its neighbourhood; it seemed therefore a sort of miracle, if this vein should have escaped them. Little bits of quartz, on which the gold seemed to have grown, had been found, but fragments of quartz containing gold had not come to his knowledge.

Mr. Maclaren suggested that "the present auriferous deposit, in fact, represents the concentrates of a pyritous lode, which has suffered degradation."* For this idea, there ap-

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 497.

peared to be facts that would tend to such a conclusion. On the ridge, where the Macreddin stream and the Mucklagh brook had their source, there was a large ramp or bed of gossan: this would seem to indicate the presence of a pyritous lode, which, however, had not been found, although an open-cast was made across the accumulation. A trace of gold was said to have been found in this gossan. In the upper portion of the Coolbawn stream, there was no black auriferous sand, but when it crossed the slope below the Moneyteigue lode (iron and pyrites) the black sand appeared with both gold and tin. In the upper portion of the Gold-mine valley stream no gold occurred, but when one came to the shed from the Ballinasilloge and Ballycoog pyritous lodes the gold and tin immediately appeared. In the upper portion of the Monaglogh and Killahurler streams, there was no gold: but lower down were the Lyra placers. In connection with these streams, no mineral-lode had been recorded; although in the valley of the adjoining townland of Mongan, there was an excessive ramp of gossan strongly suggesting a pyritous lode. In the valley below Lyra, there was little or no drift, but to the north-east in a dry gulch-placer, there was large gold similar to that at Lyra; while farther north, at Clonwilliam slate-quarry, while making the mill-pond, some gold was turned up. It should be mentioned that some men who had worked in California, Australia and the Transvaal believed that a mass of green tuffose rock, similar to that on which Mr. Acheson put down his shaft, was a gold-bearer.

The above-mentioned lodes and mineral accumulations might supply the gold and black sand: but where did the tin come from? As the granite of Croghan was of the same age as the newer granite of Cornwall and Devon, it had been suggested that the granite might have some connection with the tin: but against this was the fact that the tin disappeared as the granite was approached. In the diggings, where there was tin, large gold was found, but if the tin disappeared the gold also went or became small (eyesills).

There was another feature in the area that might require consideration. Mr. Acheson's drives in connection with the "Red Hole," and Mr. Weaver's cut farther south-west at the road, appeared to suggest that originally valleys were denuded in the boulder-clay, much wider than the present ones: and that these

were filled by a sub-glacial accumulation. Mr. William Mallet suggested that the filling was due to "mud débâcles," the slush formed during the final melting of the ice and snow, that slid into and down the valleys. That such movements did take place was proved by the bending over of the tops of the slates and other rocks. This, by the American geologists, was called the "Champlain epoch" or "the time of the floods proceeding from the melting ice." These, as in Ireland, covered the slopes with rearranged drift.* This newer drift contained more or less angular shingle, while the black sand and accompanying stuff had in them rounded fragments. The nugget and grain-gold were usually abraded, but some were frosted as if gold had grown on them, while most of the eyesills seemed to have grown like the moss and dendritic gold in some of the Californian placers. It might, therefore, be suggested that the abovementioned pyritous lodes were denuded during the Glacial Period, and that the gold-sands and their adjuncts were washings from the portion of the Glacial Drift that was removed when the valleys were originally excavated. Such a theory, however, could not be accepted without due consideration. There was very little evidence as to the direction in which the ice was moving. To the north of the Darragh water, north and south of Knocknamohill house, the striæ pointed to the south-east, and south of the Gold-mine valley about 1 mile east-north-east of Slievefoore they pointed in the same direction, but at the summit of the hill they ran nearly eastward. The south-easterly direction would answer for the mineral detritus in the Macreddin and the Gold-mine valley areas, but not for the Coolbawn valley. In the latter case, although there were no proofs, it was possible that the line of hills or spur extending north-eastward from Croghan Kinshelagh had diverted the trend of the ice-flow to a south-westerly direction, in which case the mineral-detritus from the Moneyteigue lode would have been carried into the Coolbawn valley. If this glacial theory was correct, why was the gold not more widely distributed? While, if the gold-sands were adjuncts of the "Champlain epoch" why was the gold-sand below the recent drift, and not scattered through it?

In county Meath, there was said to be a quartz-lode carrying

* *Report of the Geological Exploration of the Fortieth Parallel*, 1878, vol. i., "Systematic Geology," by Mr. Clarence King, page 459.

gold, at the contact of Carboniferous Limestone and the Ordovician rocks. A specimen obtained by him (Mr. Kinahan) had across it an auriferous streak, $\frac{3}{8}$ inch wide, having in it a pure vein from a string to $\frac{1}{4}$ inch wide. The gold was peculiar, carrying with it grains of blende, a very rare associate f gold. Prof. Dana only mentioned two localities. As circumstances had prevented the place from being visited and the find guaranteed by a competent authority, the locality for the present would be left unnamed.

Mr. Maclaren ignored the West Wicklow gold-mines, in the eastern plain of the Liffey, recorded in the *Annals of the Four Masters*, also the auriferous lodes of Cork; one need not therefore say more about them, except that there seemed to be a future for south-west Cork.

If the gold of the Gold-mine valley came from the detritus of the mineral-lodes in the Carysfort mining setts, there ought to be in the tract of country north-west of the valley, between it and the mineral-lodes, gold-placers besides those in Ballintemple stream and in the north-western branch of the Gold-mine valley stream. It should be mentioned that in the gossan of the lodes at Ballinasilloge, a trace of gold was detected. The approximate position of the lodes of the Carysfort mining setts and the known gold-placers are shewn in Fig. 1 (Plate VI.). According to the conclusions arrived at by Mr. J. M. Maclaren, the gold-ores of the British Isles have their genesis in the older rocks. In regard to the gold of Eastern Wicklow, he (Mr. Kinahan) had come to a similar conclusion. The mineral-lodes, for reasons given elsewhere, are probably of either Carboniferous or Devonian age, the minerals being leached out of the associated Ordovician rocks. In south-west Cork, however, the auriferous lodes were post-Devonian, the ores being leached out of the associated Devonian rocks of the country. If there were an auriferous quartz-lode in county Meath, the lode ought to be post-Carboniferous, but the gold might have come from the Ordovician rocks, the lode being at the contact of both.

Prof. J. P. O'Reilly (Dublin) wrote that, in matters of mining, there was, however, always the speculative or prospective side, and perhaps sufficient justice was not always done to

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To illustrate Mr. G. H. Kinahan's "Notes on the Occurrence of Gold in Wicklow."

Fig. 1.

Geological Sketch-map of the Auriferous District of Wicklow, Ireland.

Cambro-Silurian—Llandeilo-Bala Beds	b^2
Granite	G
Felsites	F
Microgranites	E
Basic Tuffs	B
Gold-placers	A
Lodes in Carysfort Mining Sett.	

Scale, 1 Mile to 1 Inch.

NOTE: This sketch-map, being copied from Mr. Maclaren's map, does not agree with the revise of the Geological Survey map lodged in the Geological Survey Office, Dublin.

The North of England Institute of Mining & Mechanical Engineers
Transactions. 1903-1904

Andw Reid & Compy Ltd Newcastle upon Tyne.

the "prospectors," the hardy adventurers of "perfervid imagination," the successors of the "Argonauts," the "Cossacks" of science and discovery; and speaking on their behalf he (Prof. O'Reilly) would wish to point out that there was still something to be said in favour of further search for gold in Great Britain, since, carefully examined and compared with other countries, the rocks and their associated minerals point in that way. Nobody had attempted to classify and enumerate the quartz-reefs and lodes of this country, still less to give some analyses or assays of them, and yet they were very abundant, as might be learned by the perusal of the *Memoirs* of the Geological Survey. Again, the association of diorites with gold was, he thought, one of the things that might be considered as certainly frequent if not constant. He was much struck on reading Sir Richard Griffith's opinion on the lead-veins at the contact of the granite with the Carboniferous formation in the counties of Dublin and Wicklow: Sir R. Griffith said that "the whole of the true veins which have been discovered in the county Wicklow are close to, or within a short distance of, the junction of the granite and the stratified rock. The number of these veins is probably immense, as there is no instance of any precipice along the eastern line of junction, in which veins containing lead have not been discovered, and we may reasonably infer that veins are equally numerous in those parts, where the rock is not exposed to view. . . . . From this fact, it may be concluded that in the whole line of the granite-boundary we may expect to find lead-mines."* Sir. R. Griffith was an experienced engineer and geologist, and subsequently drew up the excellent and useful geological map of Ireland known by his name; and he became famous as head of the Land-valuation Department. Now, in the vicinity of Dublin, at Dalkey, not only is there an old and abandoned lead-mine, but ribs of galena occur in the granite in such a manner as to lead him (Prof. O'Reilly) to presume that the gut or narrow strait between Dalkey Island and the shore, so marked in its direction, really contains the main lode: but, of course, under almost impossible conditions as regards exploration and working. Of course, argentiferous galena is, in its way, a gold-ore, hence the interest of the whole question.

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* *Fourth Report on Irish Bogs*, pages 172 and 173.

DISCUSSION OF MR. T. ADAMSON'S PAPER ON "WORKING A THICK COAL-SEAM IN BENGAL, INDIA."*

Mr. George A. Stonier (Chief Inspector of Mines in India) wrote that he agreed with the remarks of Mr. R. R. Simpson and Mr. James Grundy† on the methods of working at Giridih described in Mr. Adamson's paper. The security of the miners under the systems of working and the very careful supervision in vogue at these collieries was shown by Table I., which gave statistics for the collieries of the East Indian Railway Company and the coal-fields of Bengal, during the past three years.

Table I.—Deaths by Accidents in India.*

Collieries.	Years.	No. of Deaths by Accidents.	No. of Persons employed daily per Death	Annual Output per Death.	Output per Annum.
				Tons.	Tons.
East Indian Railway Company	1900	2	3,672	264,187	528,374
	1901	3	2,626	187,056	561,169
	1902	2	3,950	306,894	613,789
Bengal Coal-fields	1900	41	1,776	121,426	4,978,492
	1901	42	1,896	135,806	5,703,876
	1902	44	1,893	142,484	6,269,294

* The details of the five Bengal coal-fields are given in Mr. Stonier's reports for the years 1901 and 1902.

While in Australia, he (Mr. Stonier) made the following notes on the method of working a thick seam at the Australian Agricultural Company's Colliery, at Newcastle, New South Wales. The Bore-hole seam is 17 to 20 feet thick, contains 15 feet of coal, and has a dip of about 1 in 20, which varies in direction. The coal is bituminous and fairly hard. The cleat is well developed, and runs in one direction throughout the mine. Faults are uncommon, and dykes are few in number. The amount of cover varies from 230 to 320 feet. Naked lights are used by the workmen. The system of working the seam is divisible into two parts:—(*a*) The formation of the pillars: and (*b*) the extraction of the pillars.

(*a*) In the first lift (Fig. 7, Plate VII.), the headings, 12 feet wide, are driven more or less parallel to the cleat of the coal; and

* *Trans. Inst. M.E.*, 1903, vol. xxv., pages 10, 192 and 396; vol. xxvi., page 19; and vol. xxvii., page 10.

† *Ibid.*, vol. xxv., pages 192 and 399.

bords, 18 feet wide, are opened out at right angles to the cleat: leaving ribs, 36 feet wide, which are made into pillars, 210 feet long, by cut-throughs, 12 feet wide. The holing is made in the bottom-section of the big tops, immediately above the morgan (a dark bituminous shale), and the big tops, 4 inches coal, and the little tops (or in all 7½ feet of coal and 9 inches of shale) are excavated. The roof, formed by the parting, 1 inch of sandy shale and overlying coal, is generally sound and requires very little timber. The coal is loaded into tubs, and the shale is left temporarily in the bords and headings; but before commencing the second lift, this shale is stowed in bords from which the bottom coal has been won. The air-current is passed to the working-faces along passages, bratticed from the bords in the usual manner.

The miner receives the district hewing-rate of 4s. 2d. per ton for round coal, with an additional 1d. per ton for each inch of thickness of band excavated and ⅛d. per ton for small coal: the latter passes through screens, with bars ¾ inch apart, and amounts to 20 or 25 per cent. of the total amount of coal won.

In the second lift, the bottom coal is won in the bords and headings. Beneath the coal worked in the first lift, there are 2 feet of dark bituminous shale, covering 3 feet of coal: the whole thickness of 5 feet is excavated. As the face of the heading advances, the excavated coal is loaded into tubs, and the shale is packed on the upper side, leaving space for the rails on the lower side of the road: this space is ultimately filled with shale from the bords on the rise side, which are worked in the same manner, but the rails are placed in the centre of the bord (Figs. 1, 2 and 3, Plate VII.).

In the third lift, the top band (4 feet 2 inches thick) is worked in the bords for their whole length, except 15 feet back from the roads, and the roof of shale is allowed to fall. The shale from the preceding lifts generally fills the bord to within 6 feet of the top band, so that the latter is within easy reach.

(*b*) Only the upper thickness of 11 feet 2 inches is won from the pillars, and no attempt is made to mine the bottom coal, 3 feet 5 inches thick, which amounts to 8½ per cent. of the total quantity in the seam. A commencement is made 15 feet from a heading, and the pillar (210 feet long and 36 feet wide) is worked at right angles to the cleat for a width of 18 feet and a length

of 90 feet, the rails being kept close up to the face and the coal loaded directly into the tubs. Round props, 4 inches in diameter, are set 1½ feet apart to support the roof. The remaining width, 18 feet, is worked back to the 15 feet stump at the heading, and the timber is withdrawn. The other half of the pillar is worked from the adjacent heading in a similar manner (Figs. 4, 5 and 6, Plate VII.).

The final operation is the removal of the stumps, 15 feet wide (one on each side of the heading), and the top coal along the headings and in the bords adjacent to the headings.

It will be seen that an attempt is being made to win 91 per cent. of the total amount in the seam, but the expenses are high compared with the costs in Indian collieries.

DISCUSSION OF MR. W. LECK'S PAPER ON "AMBULANCE-INSTRUCTION AT MINES."*

Mr. George A. Stonier (Chief Inspector of Mines in India) wrote that in India, although hospitals and medical attendance were provided in all the mining-fields, instruction in first-aid had only been introduced at the East Indian Railway collieries in Giridih, Bengal presidency, where 8,000 persons were daily employed. The medical staff cost £472 per year, and consisted of one assistant-surgeon (a native) and five native doctors, who were housed at different places, and were available at short notice for sickness and accident-cases. They also instructed the deputy overmen and sirdars (corresponding to back-overmen and deputies in England) in first-aid and held a weekly drill, so that the acquired knowledge was not forgotten. The special rules of the collieries referring to first-aid were as follow:—

28.—*Duties of Sirdars.*—Shall have a fair knowledge of first-aid to the injured, and shall for that purpose attend drill and instruction in this matter as ordered by the managers.

29.—Shall, in case of accident, send at once for the nearest European, the nearest native doctor, and the ambulance and accident-boxes.

161.—*Duties of Assistant-surgeon.*—Shall inspect the accident-boxes and ambulance-appliance, whether placed above or underground, frequently, and report the state of them to the superintendent, and see that the native doctors carry out the duties laid down for them.

* *Trans. Inst. M.E.*, 1903, vol. xxv., page 354; and vol. xxvi., pages 154 and 258.

C.D. OF FIG. 1.

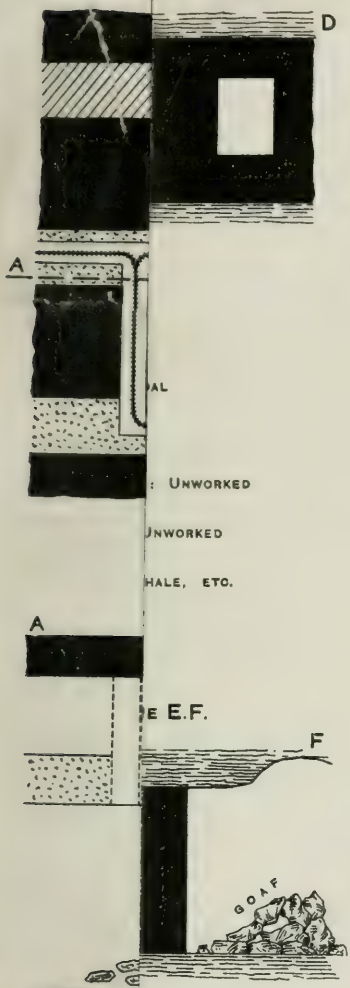
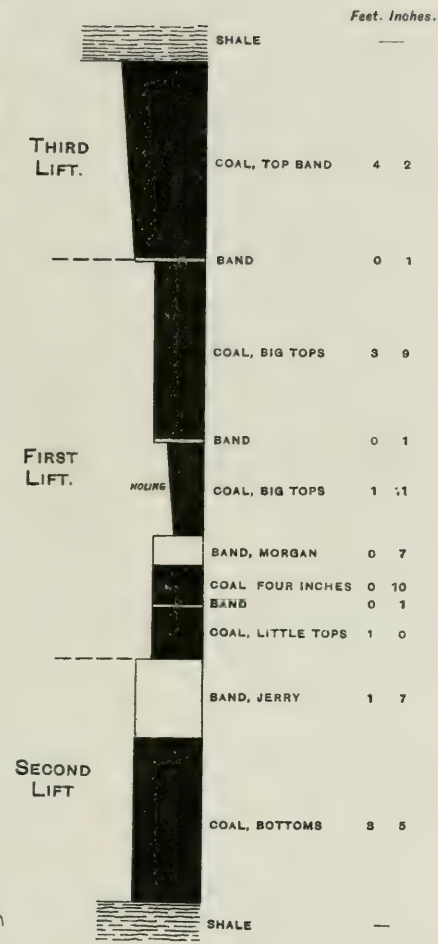
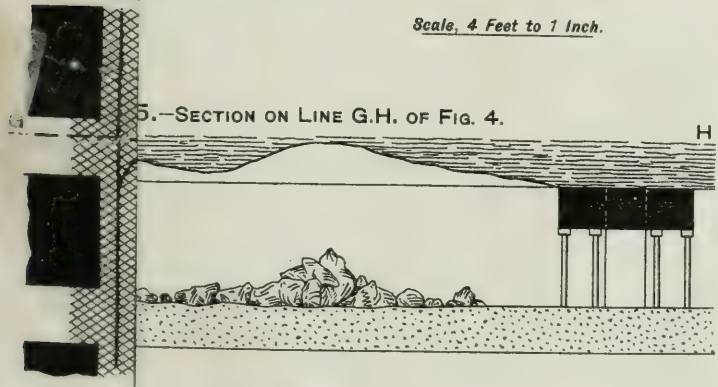


FIG. 7.



Scale, 4 Feet to 1 Inch.

5.—SECTION ON LINE G.H. OF FIG. 4.



...ale, 60 Feet to 1 Inch.
...le, 20 Feet to 1 Inch.

FIG. 1.—PLAN, SHOWING SECOND LIFT IN PROGRESS.

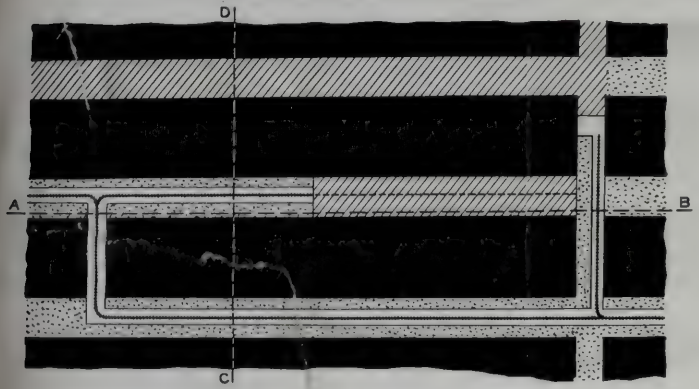


FIG. 2.—SECTION ON LINE A.B. OF FIG. 1.

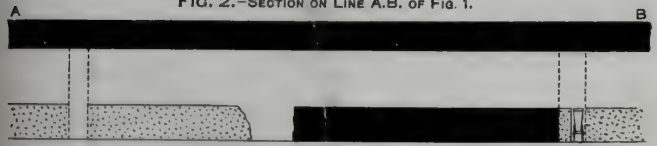


FIG. 4.—PLAN, SHOWING PILLAR-WORKING.

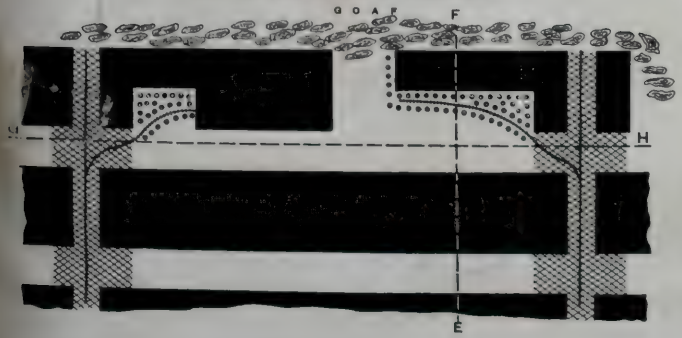
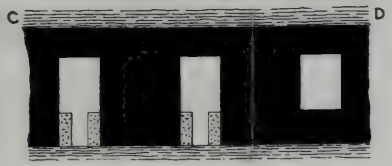


FIG. 3.—SECTION ON LINE C.D. OF FIG. 1.



REFERENCES.

- PILLARS OF COAL
- TRAMWAY
- BOTTOM COAL: UNWORKED
- TOP COAL: UNWORKED
- PACKING OF SHALE, ETC.

FIG. 6.—SECTION ON LINE E.F. OF FIG. 4.

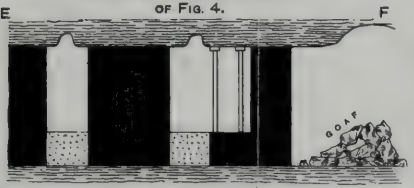
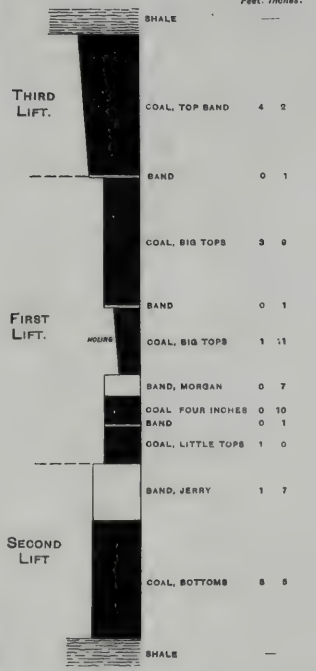
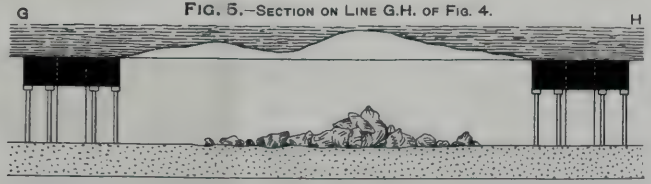


FIG. 7.



Scale, 4 Feet to 1 Inch.

FIG. 5.—SECTION ON LINE G.H. OF FIG. 4.



Horizontal Scale, 60 Feet to 1 Inch.
Vertical Scale, 20 Feet to 1 Inch.

162.—Shall see that sirdars are properly instructed in first-aid, and kept efficient in the same.

165.—*Duties of Native Doctors.*—Shall promptly attend all accident-cases, underground or on the surface, as the case may be, and all cases of serious illness,

167.—Shall instruct the sirdars in first-aid, and drill them regularly.

Accident-boxes are kept on the surface and underground, and they contain:—4 ounces of carbolic oil, 4 ounces of ferric-perchloride liquor, 1 ounce of chloroform, 1 ounce of opie tincture, 2 ounces of ammonia carbonas, 2 ounces of boric acid, 1 ounce of iodoform, 2 skeins of ligature (hempen and silk),

FIG. 1.—ASSISTANT-SURGEON TESTING THE RESULT OF AN IMPROVISED TOURNIQUET ON THE FEMORAL ARTERY.

2 suture-needles, 2 bundles of tape, 2 dozen safety-pins, 2 ounces of lint, 12 feet of mulmul (muslin), 2 perchloride towels, 1 piece of soap, 4 ounces of emp. resina, 3 feet of plaster-cloth, 2 sponges, 1 minim measure, 1 pound of perchloride cotton-wool, 1 tourniquet-screw, and bandages (one, 6 inches wide; three, 4 inches; six, 3 inches; twelve, 2½ inches; four, 1½ inches and three double-headed). In a separate bundle are the following

splints:—1 pair of clines legwood, 3 pairs of common arm, 1 liston-wood.

The course of action in cases of accident is as follows:—The injured man is at once moved to a safe place near by, and first-aid is rendered by a sirdar or deputy-overman (both of whom are natives) with bandages improvised from turbans (*pagri*) and pick-handles; while three messengers are bringing (1) an accident-box, (2) a native doctor, and (3) the nearest European. The native doctor, on his arrival, puts on fresh bandages, if neces-

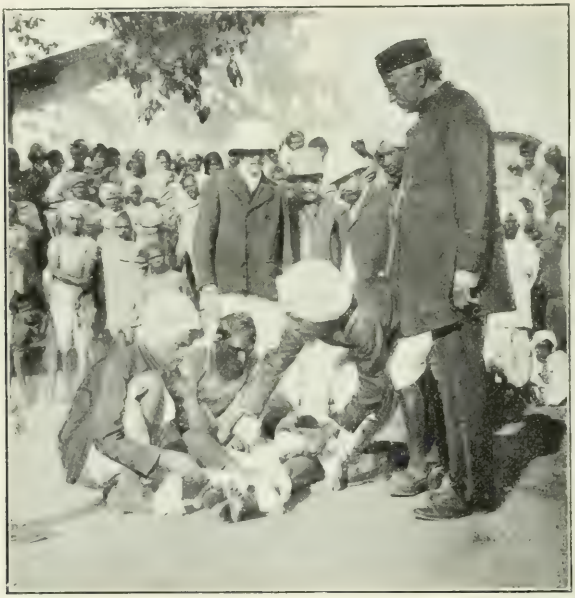


FIG. 2.—SIRDAR AND DEPUTY-OVERMAN SETTING A FRACTURED LEG WITH PICK-HANDLES AND A TURBAN.

sary, from the accident-box, and makes the patient comfortable. He then superintends his removal on a light iron-stretcher to the surface and the hospital, where he hands the patient over to the assistant-surgeon, who treats the case surgically.

Fig. 1 shows a sirdar stopping bleeding at the femoral artery by a tourniquet improvised from a turban (*pagri*) and a stone. The assistant-surgeon may be seen examining the pulse of the

ankle, to ascertain whether the bandage would stop the bleeding. Fig. 2 shows a sirdar and deputy-overman setting a broken leg

Fig. 3.—Patient being Placed upon an Ambulance.

with pick-handles and turbans. Fig. 3 shows the patient being placed on a stretcher under the charge of the assistant-surgeon.

Mr. W. C. Mountain read the following "Notes on Electric Power applied to Winding in Main Shafts":—

NOTES ON ELECTRIC POWER APPLIED TO WINDING IN MAIN SHAFTS.

By W. C. MOUNTAIN.

In the following short paper, the author will attempt to describe some typical Continental and English winding-gears, in order to give an idea of what is being done in the way of applying electrical power to this class of work.

Very little in the way of electric winding has been done in this country, and considerable doubt appears to exist as to the advantage of the use of such gear. The author, however, is quite certain that it will pay colliery-owners to look carefully into this matter; and, while he does not wish to advocate the indiscriminate application of electricity for everything about a pit, and recognizes that every case will have to be considered on its merits, still he thinks that a description of some of the principal German winding-gears will be of interest to colliery-owners in this country.

The firm with which the author is connected has installed a few electric winding-gears in this country, and, while they cannot compare with those on the Continent in size, they have nevertheless been very successful. Later on in the paper, a description of such a gear, fitted by the author's firm at a colliery of the Shelton Iron, Steel and Coal Company, Limited, and also at the Heckmondwike colliery, is given.

The author will begin by describing the two principal examples of electrical winding to be seen in Germany, namely, those at the Zollern II. colliery, Merklinde, and at the Preussen II. colliery, near Dortmund. One can easily understand that there are advantages in the way of smooth running, starting and stopping, etc., to be obtained by the use of electricity, but the fact that they are economical to operate is remarkable. This, however, is shown by the figures given further on in the paper.

Zollern II. Colliery.

Introduction.—Zollern II. colliery is one of the latest, and unquestionably the finest, in Germany. It has been equipped on the most modern lines, the surface-arrangements are very complete, and the buildings are all fine examples of architecture of their kind.

The offices are situated in the centre of the colliery-yard, and are very elaborately arranged. Bath-rooms are provided for the officials, and special bathrooms in white marble with nickel and oxidized-silver fittings, for the directors.

An ambulance and first-aid room, situated near the entrance-gates, is equipped with all necessary instruments and material for performing a complete operation. As the "worm" is prevalent in Westphalia, a special building is provided for patients suffering from this complaint. All workmen, showing symptoms of this disease, are isolated from their fellow-men, and must use the special rooms provided for them.

Bathrooms for the use of the men are compulsory, and a splendid bathroom has been provided, in which 1,500 men can bath at one time. A partitioned portion for boys under 16 years of age, is capable of accommodating 500. Everything seems to have been provided for the comfort of the men, and the heating arrangements are most elaborate and carefully thought out. Adjoining the bathroom is a waiting-room, where the miners wait their turns to descend, and it is used as a dining-room by the surface-men.

The fitting-shop contains a horizontal planing-machine, three lathes, two drilling-machines, and a pipe-screwing machine; all these are driven from one motor. The blacksmith's shop contains 6 or 8 fires, a compressed-air forge-hammer (supplied with air from the main air-compressor situated in the power-house), and a motor-driven blower. All the necessary joinery-work for the colliery is carried out in the joiner's shop, containing a band-saw, a circular saw, and a planing-machine, all motor-driven.

Electric Power-house.—The power-house is a splendid steel-and-brick building, about 330 feet long and 80 feet wide, and it has a domed glass roof. The building and foundations cost about £12,500 (250,000 marks).

Engines.—Two sets of generating machinery are installed at present, and another similar set is on order. Each set consists of a triple-expansion horizontal engine with 4 cylinders, coupled tandem, of the following dimensions:—The high-pressure cylinder is 31·50 inches (800 millimetres), the intermediate, 39·37 inches (1,000 millimetres); and the two low-pressure, 43·31 inches (1,100 millimetres) in diameter respectively, with a stroke of 47·24 inches (1,200 millimetres). The piston-speed is 705 feet (215 metres) or 90 revolutions per minute. The pressure of the steam, at the engine, with full load, is 147 pounds per square inch or 10 atmospheres. The engines are made by the Maschinenbau Aktien-Gesellschaft.

Generators.—Each engine has, mounted on its crank-shaft, a continuous-current 16 pole generator producing 1,100 kilowatts at 525 volts and 2,100 ampères, when running at 90 revolutions per minute. These generators supply current to the whole of the machinery at the colliery, and one is sufficient to keep everything going, including electric winder, washery, fans, air-compressors, workshops and pumps. The average load on one generator is 750 kilowatts.

The observed readings, when running at 88 revolutions per minute, during the writer's visit on March 2nd, 1904, were:—

	Atmospheres.	Pounds per Square Inch.
Engine: Steam-pressures on cylinders—		
High pressure	6·5	96·0
Intermediate pressure	2·9	42·5
Low pressure	1·4	20·5
Steam-jacket	4·0	59·0
Vacuum	0·8	11·8

Generator: The average load read on the meters was 520 volts, 1,050 to 1,400 ampères, or 550 to 730 kilowatts. These readings, however, rise, at times, to 1,500 ampères.

Main Switchboard.—The switchboard is composed entirely of marble, the frame being of brown, and the switch-panels of white, marble. It is arranged as a double board, that is, two generator-panels and a battery-panel are placed in front, while the distributing-panels, situated in a room behind the main panels, are mounted in an iron frame. The two generator-panels are each fitted with a double-pole switch, a double-pole circuit-breaker, a field-rheostat, a voltmeter and an ammeter.

The battery-panel is of the usual type, with charging and discharging switches and meters. Three spare panels are provided for future extensions. All the connections, behind the boards and to the battery, are solid round copper, making an excellent fireproof arrangement.

Lighting-plant.—A motor-generator is provided for lighting: a motor of 500 volts and a generator of 110 volts.

Battery of Accumulators.—This battery consists of 250 Tudor cells, and was originally installed in connection with the electric winding-gear, but it was not found quite satisfactory. A motor-generator has taken its place. The cells are of the following capacity:—5,000 ampère-hours, 500 volts, and 250 cells. The battery, now used as a standby, is capable of running the whole plant, including the winder, for one hour, or of supplying 500 ampères for 10 hours. This enables the main engine to be shut down for a considerable time at week-ends.

The author was informed, however, in view of the experience gained on this plant, that a battery will not be installed for future work of this kind.

Battery-switches.—A most elaborate arrangement of battery-switches has been installed to work the winding-engine. These, however, can be entirely dispensed with since the motor-generator has been installed.

Charging Booster.—A booster, consisting of a motor and two generators, is provided for charging the battery.

Electric Winding-engine.—This is the largest electric winding-engine in existence, and was exhibited in the Düsseldorf Exhibition of 1902. It was constructed by the Bergwerksverein Friedrich-Wilhelmshütte, Mülheim-on-the-Ruhr, and the electric machinery by Messrs. Siemens and Halske, Berlin (Fig. 1). The drum, of the Kœpe type, is 19·69 feet (6 metres) in diameter. The rope, of round stranded steel-wire, is 1·97 inches (50 millimetres) in diameter. At present, the engine is winding from the depth of 984 feet (300 metres).

Two electric motors are fitted, one on each side of the drum. The shaft runs in two bearings only, on the outer ends of the

motors. This shaft is 20·47 inches (520 millimetres) in diameter, 23·62 inches (600 millimetres) long in the journals: and 25·98 inches (660 millimetres) in diameter in the drum-boss. The distance between the centres of the bearings is 18·04 feet (5·5 metres). The distance between the centres of the motors is 8·20 feet (2·5 metres).

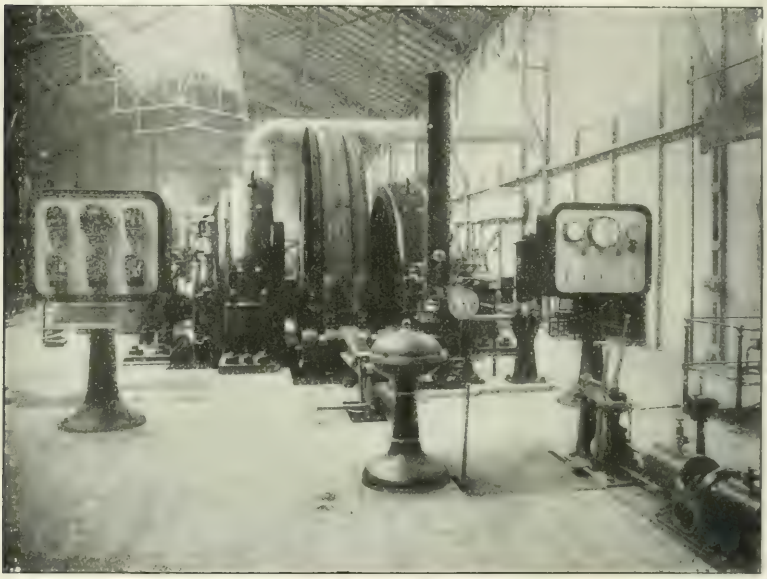


FIG. 1.—ELECTRIC WINDING-GEAR FOR ZOLLERN II. COLLIERY.

At present the maximum winding speed is 32·81 feet (10 metres) per second, but any speed can be obtained from as low as 1 foot to as high as 64 feet per second. When the lower seams are reached, the winding depth will be about 3,600 feet.

At present, the engine winds about 40 loads per hour, each load being about 5 tons (5,000 kilogrammes) of coal. Each cage weighs 4 tons (4,000 kilogrammes), and 6 tubs weigh 2·4 tons (2,400 kilogrammes). At an average of 40 winds per hour and 16 hours winding, the output from this machine is about 3,200 tons per day from one shaft.

There is also a small steam winding-engine upon this shaft, used only for repairs, or for winding men.

At the upcast pit, another electric winder will be erected to draw about 1,000 tons per day.

Motors.—Two continuous-current motors, each of the following capacity, are mounted one on each side of the drum: - 705 normal horsepower, 500 volts, and 51 to 64 revolutions per minute. The field-magnets of these motors are separately excited from the main generators, and the armatures are coupled directly without switches to the generator-armature of the motor-generator (Fig. 2).

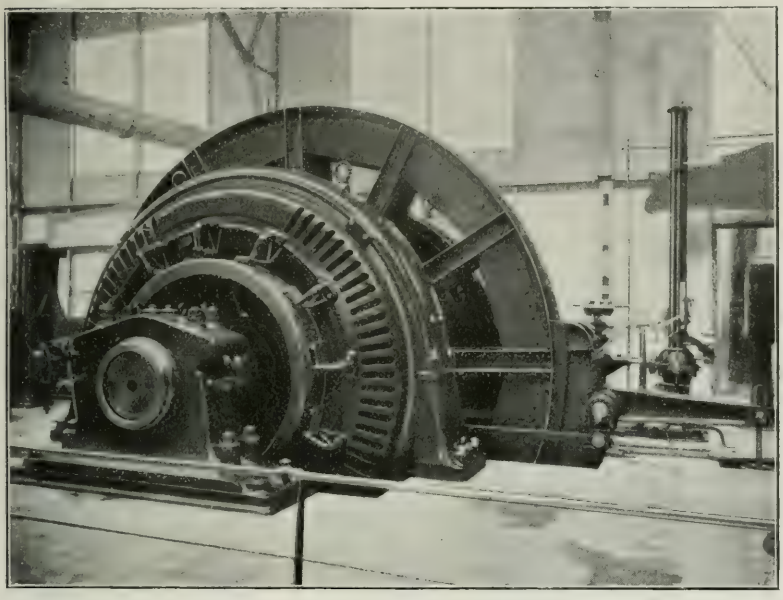
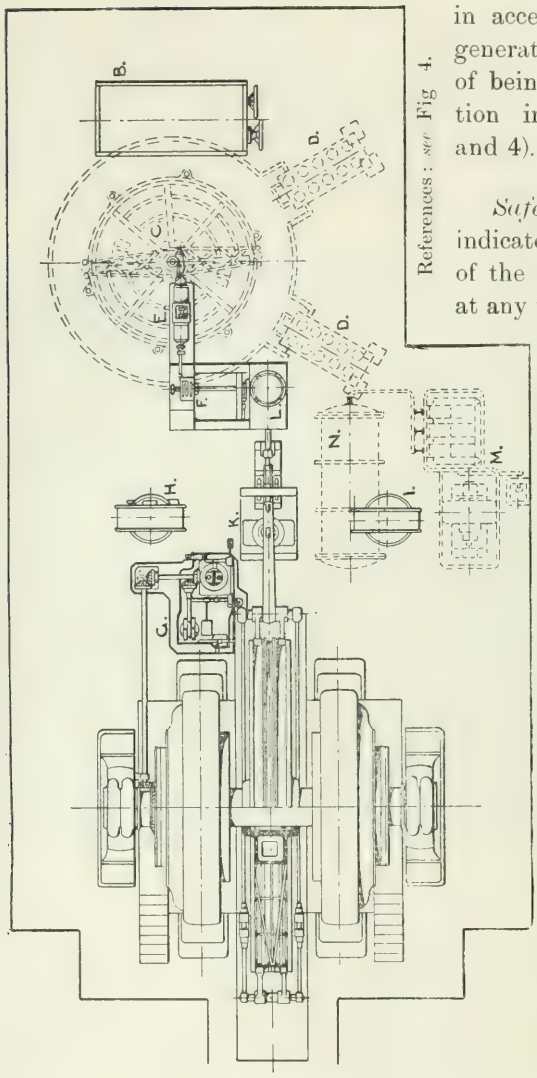


FIG. 2.—MOTOR-SIDE OF ELECTRIC WINDING-GEAR FOR ZOLLERN II. COLLIERY.

Controlling Switches.—The whole of the starting, stopping, speed-regulation and reversing is done by one switch operating a resistance placed in the shunt-field of the generator of the motor-generator. By this means, only currents of small magnitude are dealt with, consequent burning of contacts is avoided, and heavy and expensive resistances are not necessary. Practically no energy is wasted in resistance, when running the winder at reduced speeds, as it is only necessary to insert the resistance in the motor-generator field and to reduce the voltage supplied to the winder-motors as required. A small amount of energy is returned to the motor-generator from the winding-motors during retardation, and this is usefully applied



References: *see* Fig 4.

Fig. 3.—Plan of Electric Winding-gear at Zollern II. Colliery.

in accelerating the motor-generator flywheel instead of being consumed by friction in braking (Figs. 3 and 4).

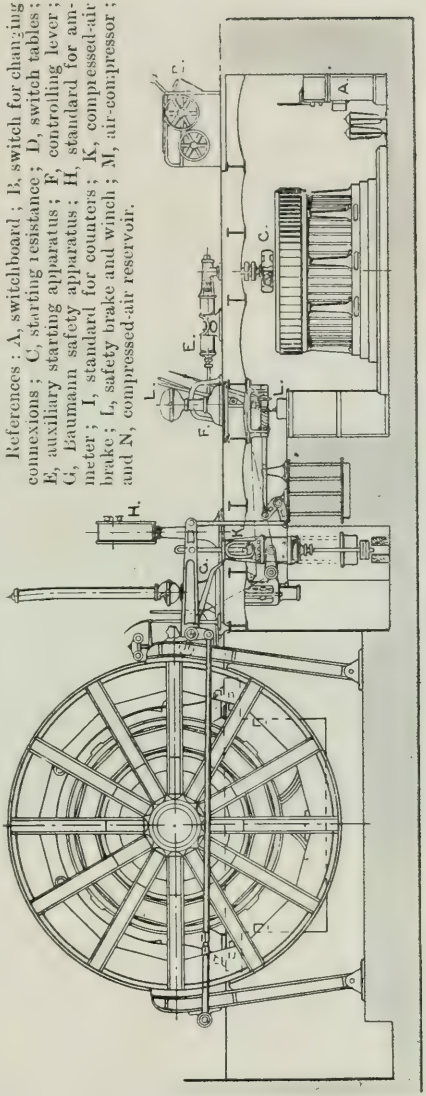
Safety-devices.—A depth indicator, fitted in front of the driver's stand, shows at any time the exact position of the hauling cage in the shaft. It works in connection with a safety device which prevents the maximum speed from being exceeded, and ensures automatically the required retardation when the hauling cage is nearing the pit-mouth. Should the lifting speed exceed at any time the maximum speed for which the engine is designed, the brake would immediately act automatically, and the electric current would be cut off from the motors. A slowing-down device turns the starting-gear lever gradually back, and thereby switches off the electric energy automatically when the cage approaches the surface, should the driver fail to operate the lever in time. This slowing-down device is an ingenious arrangement in the form of a wedge, which is gradually inserted behind a bell-crank lever connected to the starting

gear. This was seen in operation, and worked in a perfectly satisfactory manner.

Brake.—The brake is operated by compressed air supplied by the main compressors, and, when these are standing, a small motor-driven air-compressor, of 12 horse-power, supplies the necessary air for working the brake.

Motor-generator. — The motor-generator is the Ilgner arrangement, for applying the energy stored in a heavy revolving flywheel to provide the starting effort to accelerate the large winding-engine. It consists of a continuous-current motor and generator coupled together through a heavy flywheel (Fig. 5). The parts are as follows:—

(*a*) Motor-side: 500 volts, 300 effective horsepower and 300 to 345 revolutions per minute. The magnets are shunt-wound, and an automatic resistance of a most ingenious type placed in series with them, by adding to or cutting out the resistance, maintains the motor at a practically constant speed.



References: A, switchboard; B, switch for changing connections; C, starting resistance; D, switch tables; E, auxiliary starting apparatus; F, controlling lever; G, Baumann safety apparatus; H, standard for ammeter; I, standard for counters; K, compressed-air brake; L, safety brake and winch; M, air-compressor; and N, compressed-air reservoir.

FIG. 4.—SIDE-ELEVATION OF ELECTRIC WINDING-GEAR AT ZOLLERN II. COLLIERY.

(*b*) Between the motor and the generator, a steel flywheel is mounted, and the shaft runs in two bearings, the armature of both the motor and the generator being overhung. The fly-

wheel is 12·5 feet in diameter, the width on the rim is 2 feet 7 inches, the depth of the rim is 1 foot 1 inch, the width of the centre of the wheel is 6 inches, and the total weight is 45 tons. The peripheral speed is 14,000 feet per minute.

(*c*) Dynamo-side: This is a special generator, with a double commutator and special field-magnet system, having intermediate auxiliary poles with series-winding; and they effectually prevent sparking when the load comes on. The dynamo is rated at 550 volts, 1,800 ampères, 1,000 kilowatts, when run-

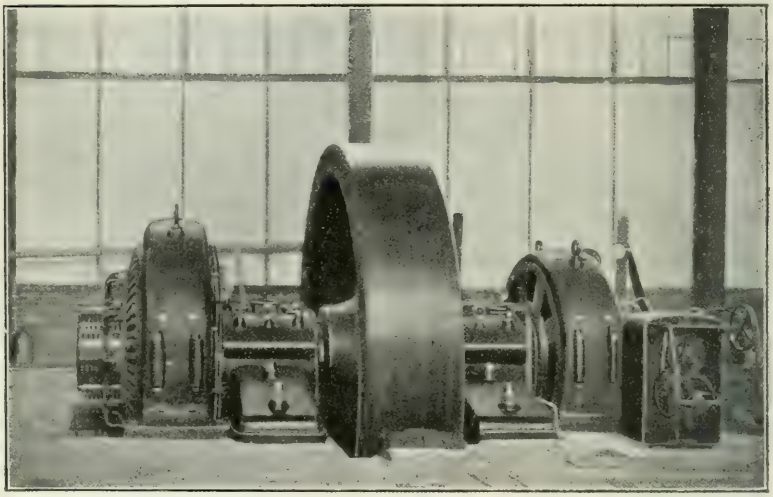


Fig. 5.—Motor-generator at Zollern II. Colliery.

ning at 300 to 345 revolutions per minute. The main magnet-coils are shunt-wound, and separately excited from the main generators. By this means, any desired voltage is obtained between zero and the full pressure of 550 volts. Through the regulation of the strength of these coils, the voltage supplied to the winding motors is regulated, and all speed-regulation on the winders is obtained by this means. The electric currents handled are therefore very small, and little or no energy is wasted in resistances.

The following readings taken from the meters in connection with the winder and motor-generator were obtained during ordinary working conditions:—

(*a*) Motor-side: input from steam-generators, the average of several readings.

	Ampères.	Volts.	Kilowatts.
Motor starting	600	520	300
At the end of 10 minutes, when the motor has reached its full speed	100	520	52
Winder starting, the current rises steadily to	100-450	520	235
Winder running, and after reaching the top speed, the current slowly drops ...	450-300	520	160
Winder slowing down, until it stops altogether	300-250	520	130
After the winder has been standing for 2½ or 3 minutes	100	520	52

In a general way, the winding-engine makes 40 winds per hour, and as it takes about 45 seconds to wind, it is standing for 45 seconds; therefore, the flywheel never reaches its full speed; and, consequently the average input into the motor-side varies between 250 and 450 ampères at 520 volts, or 130 to 235 kilowatts, or a variation in power of little over 100 kilowatts on the steam-generators. For many minutes, the variation was between 350 and 450 ampères, or about 70 horsepower, while the winding-engine stopped and started many times. This clearly showed the efficiency of the flywheel for providing the necessary starting effort. The variation in voltage on the steam-generator was less than 5 per cent.

(*b*) Generator-side of motor-generator: Winder, standing 0 ampères, starting 1,500 ampères, running at top speed 1,000 ampères, when stopping, current dropped to 0 ampères, and reverses, momentary, to 500 ampères to *nil*. The reverse current of 500 ampères, given by the winder-motors acting as generators, assists to accelerate the flywheel of the motor-generator. The time to wind varies from 43 to 45 seconds, and as the depth at present is 984 feet (300 metres), the average speed is about 24½ feet (7·5 metres) per second, and the maximum speed is about 30 to 33 feet (9 to 10 metres) per second.

The average of several acceleration-readings was:—

	Ampères.	Seconds.
Winder, standing	0	0
,, starting	1,500	0
,, reached top speed	1,000	14
,, travelling at top speed	1,000	14
,, current cut off	0	0
,, current reverses	−500	0
,, comes to rest	0	17

On combining these observations, we can see at a glance the difference in the current supplied by and absorbed in the motor-generator during one wind of 45 seconds, as follows:—

	Motor-side or Primary side. Ampères.	Dynamo side or Winder-side. Ampères.	Time. Seconds.
Winder, standing	100	0	0
,, starting	100-450	1,500	0
,, reached top speed ..	450-300	1,000	14
,, running at top speed ...	300	1,000	14
,, slowing down	300-250	0	0
,, current reverses ...	0	−500	17

Air-compressors.—In the same power-house are two air-compressors used for supplying air to machines placed underground. One of these has been running for some time, while the other is being erected. These compressors are driven by electric motors mounted directly on the crank-shaft of the compressor. The cranks are placed at an angle of 180 degrees, and the connecting-rod is fitted direct on to the trunk-gudgeon. The motor is of the following capacity:—500 volts, 670 ampères, 75½ to 130 revolutions per minute and 450 electric horsepower. The arrangement seemed extremely neat and compact.

Ventilating Fans.—Two fans are direct-coupled to their motor; and each fan is 23 feet in diameter. At 190 revolutions per minute, the air discharged is 176,600 cubic feet (5,000 cubic metres) per minute, and the water-gauge is 6·69 inches (170 millimetres). The motors generate 250 horsepower, at 500 volts and 435 ampères.

Coal-washery.—The coal-washery is capable of washing 1,000 tons of coal per day, and sorting it into five sizes. The whole washery is driven by two motors, each of the following size:—142 ampères, 500 volts, and at 600 revolutions per minute each generates 95 horsepower.

The centrifugal pumps are driven by two motors of the same size as those described above, namely, 95 horsepower.

Boilers.—The boiler-room contains 6 double-drum Babcock-and-Wilcox boilers divided into 3 batteries of 2 each. The steam-pressure at the boilers is 206 pounds per square inch or 14 atmospheres and it is lowered through a reducing-valve to

10 atmospheres, or 147 pounds per square inch for use in the engines. The feed-pumps are driven by a motor of 22 horsepower.

During the writer's visit, 3 boilers only were at work, and duff-coal appeared to be used.

The following readings were taken from the various meters on the switchboard during ordinary working hours, and as the whole plant at the colliery is operated by electric motors, it is interesting to note the actual power going out and to compare it with the amount of steam which could be expected to pass through a cylinder, 31·5 inches in diameter and 47·24 inches stroke, running at 90 revolutions per minute.

	Ampères.	Volts	Electric Horsepower.
Coal-washery	200	520	140
Condenser	24	520	16
Ventilating fan	100	520	70
Air-compressor	430	520	300
Workshops	10	520	7
Motor-generator of winder	300	520	240
Totals	1,064	520	773

Average of readings.

Consequently, the entire colliery, including the winding-engine, requires only an average load of 773 horsepower, when winding from 1,000 to 1,500 tons per day from a depth of 984 feet (300 metres). The coal-consumption to do the whole work at the colliery can be calculated from the dimensions of the engines and the horsepower shown by the meters, and it is only 2 to 2½ per cent. of the output.

Preussen II. Colliery.

The Preussen II. colliery, one of the show-mines in Germany, has been laid out on elaborate lines. The chief point of interest, however, is the large electric winding-engine driven by a three-phase motor direct-coupled to the drum-shaft.

Power-house.—The generating plant is situated in a large power-house, adjoining the boiler-room; the air-compressors, ventilating fans and condensing plant are also situated in this power-house.

Engines.—The electric generating plant comprises three direct-coupled, slow-speed, cross-compound horizontal engines

and three-phase generators. The high-pressure cylinder is 22·44 inches (570 millimetres) and the low-pressure, 37·40 inches (950 millimetres) in diameter respectively, with a stroke of 43·31 inches (1,100 millimetres). The steam-pressure is 125 pounds per square inch, or 8·5 atmospheres. When running at 94 revolutions per minute, the engine produces 750 horsepower when condensing, and 650 horsepower when non-condensing. These engines exhaust into a central condenser, which acts for the whole plant of the colliery. The engines were supplied by the Sächsische Maschinenfabrik Aktien-Gesellschaft (Fig. 6).

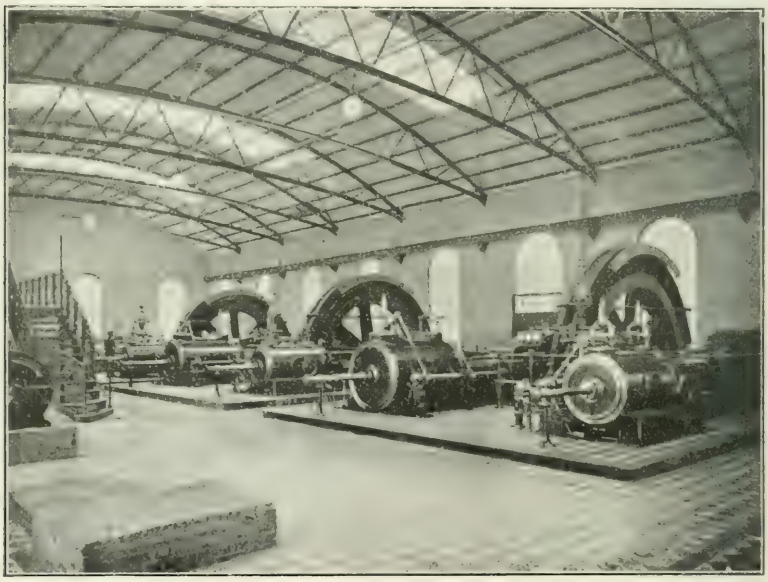


FIG. 6.—POWER-HOUSE AT PREUSSEN II. COLLIERY.

Generators.—The 550 kilowatts generators produce 2,100 volts and 150 ampères per phase, at 25 cycles per second when running at 94 revolutions per minute. These generators, supplied by the Allgemeine Elektricitäts-Gesellschaft, are of the flywheel-type, that is, the magnet-poles are mounted direct on to the flywheel. The armature-case is of the Allgemeine Elektricitäts-Gesellschaft braced type.

These three generators (two of which are necessary to keep the winding-engine running) supply current to the main switchboard, situated on a raised platform immediately behind the engine.

Exciters.—Two exciters are provided, one being driven by a steam-engine by belt on to a multipolar continuous-current generator. This is only used when all the alternators have been shut down, as the other exciter, being driven by a three-phase motor, cannot be started until an alternator is running up to its pressure. The motor-driven exciter, a three-phase motor of the slip-ring type, is coupled direct to a four-pole continuous-current generator, and provides the exciting current for the three alternators.

Switchboard.—The switchboard is of the usual Continental high-voltage type, with distance-controlled high-voltage switches. The arrangement is neat and simple: three main generator-panels being provided and an exciter-panel. It is mounted on an ornamental iron frame. The lighting panels are situated underneath the power-board platform, and are coupled to the steam-driven exciter-set, which also provides power for the lighting.

The following readings were taken on January 4th, 1904, when the winding-engine, drawing coal, came into operation:—

Winder Standing. Volts.	Winder Starting and Running. Volts.	Drop in Volts.	Ampères.	Apparent Kilowatts.
2,300	1,600	700	450	1,260
2,300	Motor holding the cage	—	50	200
2,300	1,700	600	300	880
—	2,000	Winder running	160	550
2,300	Winder standing	—	0	0
2,300	2,000	Winder moving the cage	130	450
2,300	1,400	900	200	480
2,400	Winder standing	—	0	0
2,400	1,600	800	—	450
—	2,000	—	—	100

The following readings were taken on February 29th, 1904, with the winder moving slowly, with the men in the pit:—

Volts.	Ampères.	Kilowatts.
2,300	0	Winder standing
1,900	170	200
2,300	0	Winder stopped
1,900	170	200

The speed of winding was 6½ feet (2 metres) per second. These readings repeated themselves whenever the cage was moved.

Air-compressors.—There are three horizontal two-stage cross-compound air-compressors, supplied by Messrs. Schuchtermann und Kremer.

Electric Winder.—The motor is coupled directly through its starting switches to the three-phase power-mains, no motor-generator arrangement, similar to that at Zollern II. colliery, being used. This arrangement, although simple, does not appear to be very satisfactory, as, while on a former visit, the engine was working on full load, two large alternators each of 550 kilowatts were required to keep the winder going, owing to the enormous drop of pressure caused by switching on the

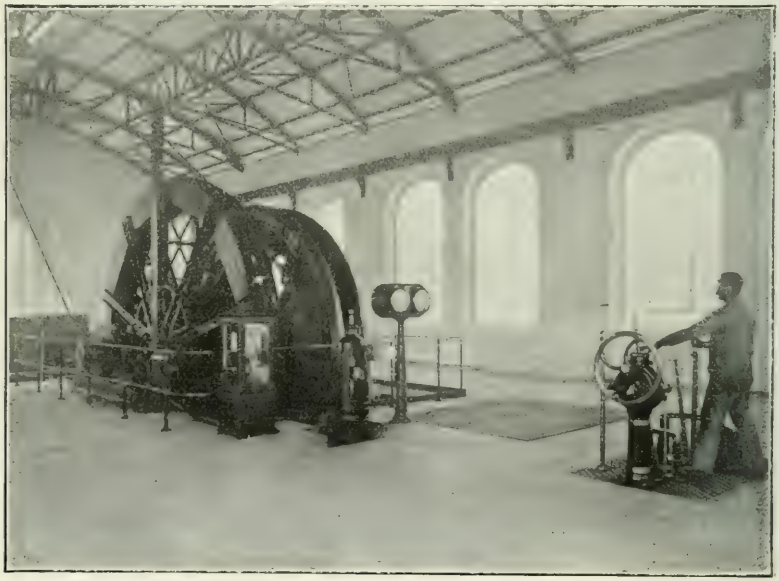


Fig. 7. Electric Winding-gear at Preussen II. Colliery.

winding-motor (Fig. 7). This is only what might be expected, as the power-factor of a large three-phase motor starting with a dead load such as a winder must do, has a very bad effect on the pressure-regulation of the alternator supplying the current. On a subsequent visit to this pit, the winding-engine was working very slowly, as workmen were fixing cables in the shaft. One generator was running, but the load was practically nothing, seeing that the cages and ropes are balanced, and the motor had

little to do except overcome the friction. The drop in pressure, was, however, very great, namely, from 2,300 to 1,800 volts, and the current was about 170 ampères. The power was about 200 kilowatts. An automatic regulator is about to be fitted, with a view of keeping the pressure more constant.

The three-phase motor, direct-coupled to the Kœpe drum, develops 950 to 1,500 brake-horsepower, at 53·5 revolutions per minute, 2,000 volts and 345 ampères (Fig. 8). The pit is 1,800

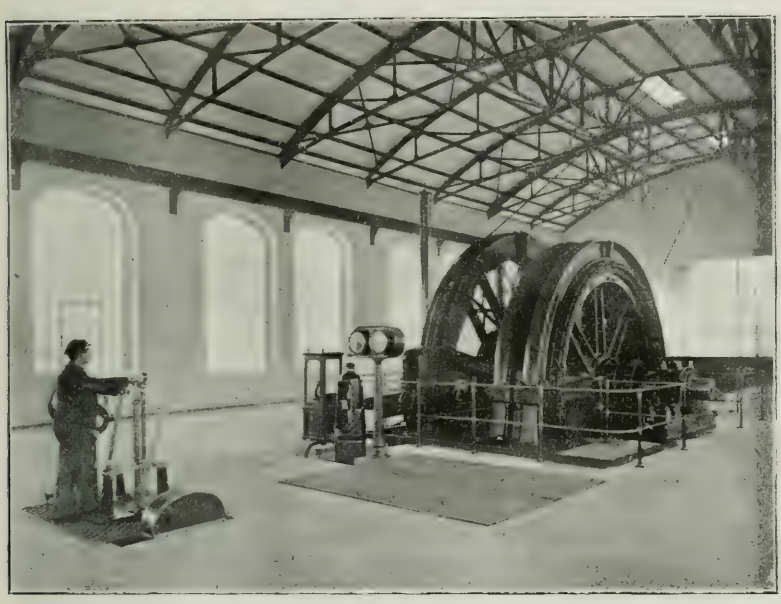


FIG. 8.—MOTOR-SIDE OF ELECTRIC WINDING-GEAR AT PREUSSEN II. COLLIERY.

feet (560 metres) deep. The winder makes 30 revolutions per wind, made in 60 to 65 seconds. The winding speed is 52 feet (16 metres) per second when drawing coal, and 20 feet (6 metres) per second when drawing men. The cage carries 6 trams, containing 3 tons (3,000 kilogrammes) of coal.

Starting Switch for Winding-gear.—Fig. 9 shows the arrangement of the controlling-gear. The current from the mains flows through the high-tension safety-fuses and the safety cut-out or circuit-breaker, then through the change-over switch for reversing the motors, and straight to the stator of the motor.

These are all the switches necessary in the high-tension circuit. The rotor of the motor, at a maximum pressure of only 300 volts, has three slip-rings, from which its current is led to the special

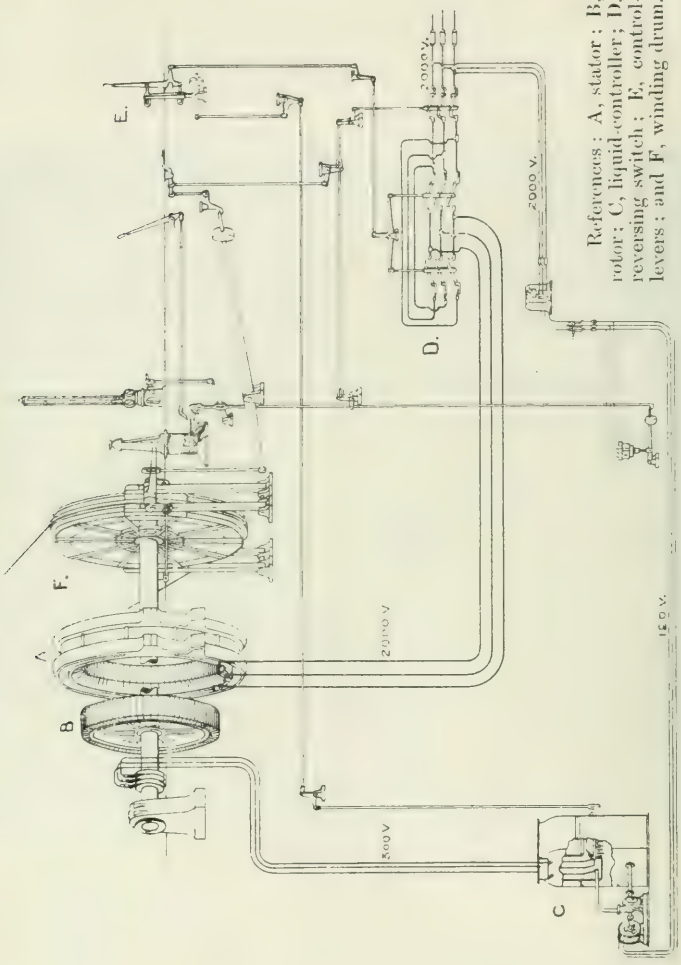


FIG. 9.—DIAGRAM OF CONNEXIONS FOR ELECTRIC WINDING-GEAR AT PREUSSEN II. COLLIERY.

liquid-starting rheostat (Fig. 10). This rheostat is a well thought-out arrangement, and is similar to that fitted on the high-speed car which the Allgemeine Elektricitäts-Gesellschaft recently succeeded in driving at a speed of 112 miles per hour. Each of the three phases of the rotor-circuit is led to electrode-plates, insulated and suspended in a tank in which circulates a

solution of soda. Instead of the plates being dipped down into the solution as in the liquid-starters made by the author's firm, the solution is made to rise up the plates, the water being pumped into the tank by a small centrifugal pump, which is kept continually running by a small motor. This pump delivers from a tank placed below the resistance-tank. When the liquid rises to its full height in the resistance-tank, it overflows into that placed below. A valve, fitted in the bottom of the resistance-tank, is worked by the driver's controlling-lever. If the valve

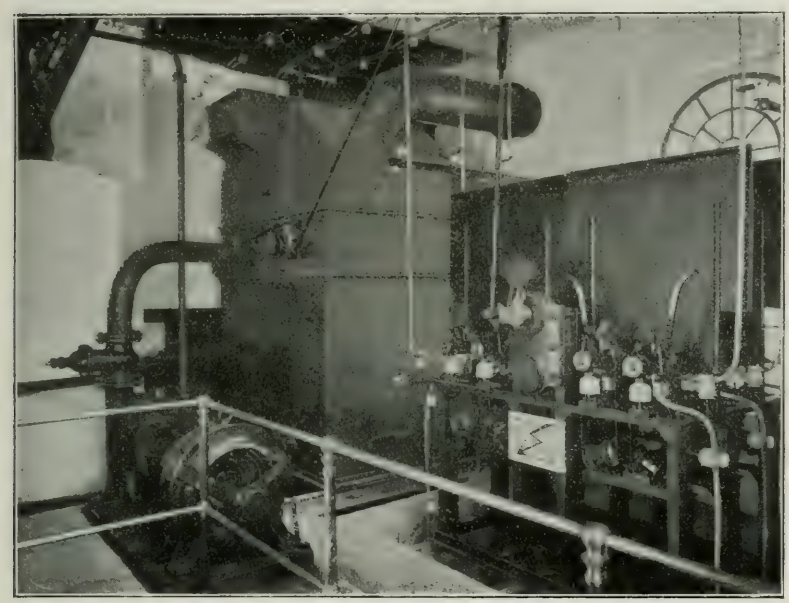


FIG. 10.—LIQUID-CONTROLLER FOR ELECTRIC WINDING-GEAR AT PREUSSEN II. COLLIERY.

is set full open, the liquid does not rise up the plates; if shut, the liquid rises upward at a regular steady rate, depending upon the rate of delivery of the fluid by the pump and independent of the driver, thus preventing him from switching on the current too quickly. The liquid can also be maintained at intermediate positions, according as the valve is set more or less open, thus giving intermediate speeds of the motor.

As compared with the Ilgner system first described, this system, although very successful, gives rather large voltage-drops

on the main generators. The heavy starting efforts come directly on them, and although the average load is not great, still two generators of 550 kilowatts have to be kept running to supply this gear, together with the rest of the electric gear at the colliery, in order to keep the voltage-drop from interfering with the rest of the motors at the pit.

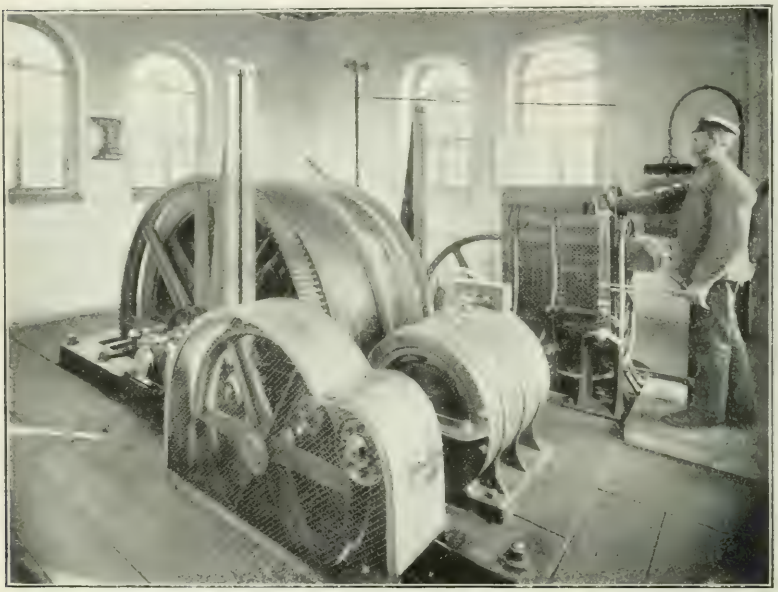


FIG. 11.—ELECTRIC WINDING-GEAR AT ARNIM COLLIERY.

Boilers.—There is a battery of 9 double Cornish boilers, with water-tube boilers set at the back of the tubes, forming a steam-generator of a very efficient type. The pressure varies from 8 to 10 atmospheres.

Fitting and Smith's Shops. These shops contain many good tools, all driven by motors.

Offices and Bathrooms. The offices and bathrooms are well arranged, but not on the same lavish scale as at Zollern II. colliery.

Having seen both the winding-gears described in operation, the writer is on the whole inclined to think that direct-

current motors are more suitable for main winding-gears, but it is impossible to lay down hard-and-fast rules, and every case must, of course, be carefully considered on its merits.

Winding-gears.

Fig. 11 shews a winding-gear fitted at the Arnim colliery, Zwickau. It is driven by a three-phase motor of a maximum output of about 80 horsepower, with 500 volts at the terminals. The electric arrangements were designed and

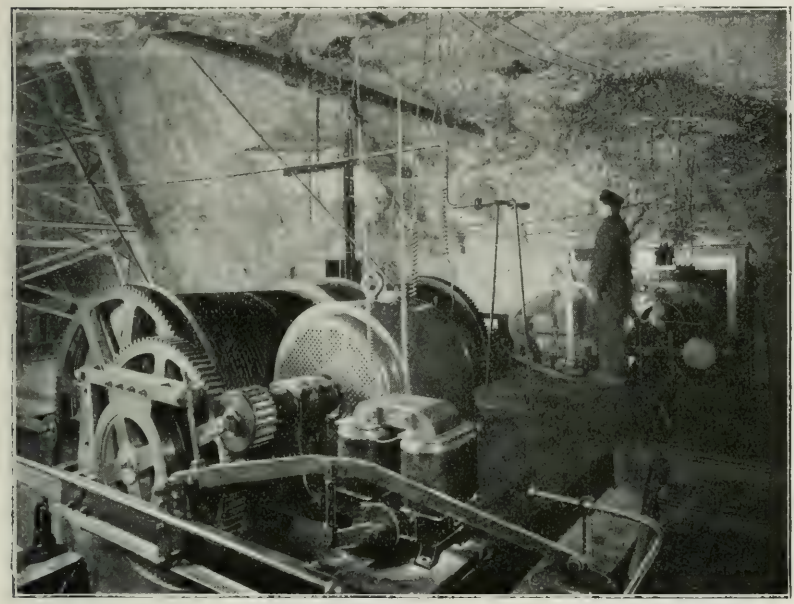


Fig. 12.—Underground Electric Winding-gear at Consolidated Salt-mine, Westeregeln.

supplied by Messrs. Siemens and Halske. This winding-gear is remarkable for the fact that it is not, as usual, placed at the side of the shaft, but directly above it, so that the hoisting ropes drive in a perpendicular direction from the winding-drum. The principal advantage of this arrangement lies in the smaller wear and tear of the rope, since it does not pass over a second pulley, and is therefore only bent once.

Fig. 12 shews a winding-gear fitted at the Consolidated salt-mine, Westeregeln. It is driven by a continuous-

current motor of 60 brake-horsepower, with 500 volts at the terminals. The brake, in daily use on this gear, is of interest, since it is fitted with an electro-magnet in such a way that the brake acts automatically in case the electric supply is cut off.

Fig. 13 shews a winding-engine fitted at the pit of the Thiederhall salt-mine. Two continuous-current shunt-wound motors are provided to drive this winder, each being constructed to give an output of 170 horsepower, and capable of running for passenger-traffic at 600 feet per minute, and for coal-winding

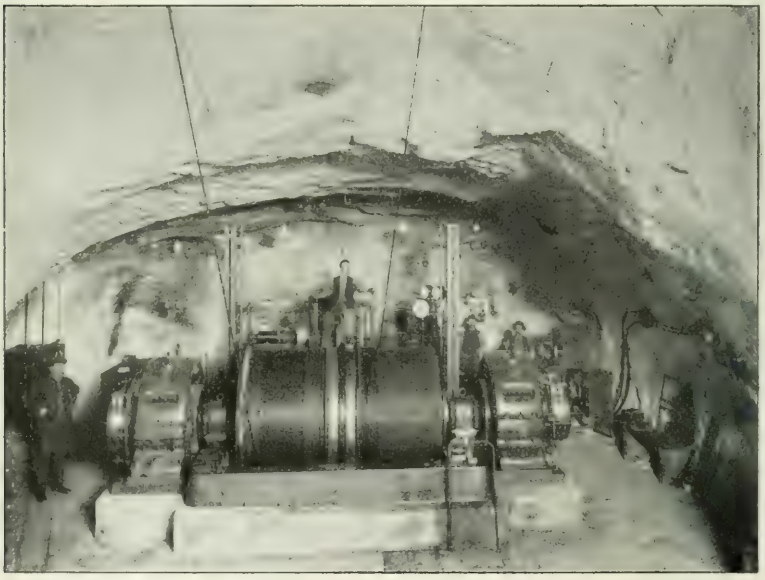


FIG. 13.—UNDERGROUND ELECTRIC WINDING-GEAR AT THIEDERHALL SALT-MINE.

at 1,200 feet per minute. Two brakes are provided, a working brake and a safety-brake. The safety-brake is provided with a weight, which acts automatically when the cage is lifted above the surface.

As before mentioned, the author's firm have fitted several winding-gears in this country, although none of them can compare in size with the larger gears erected in Germany.

Fig. 14 shews a winding-gear fitted at one of the pits belonging to the Shelton Iron, Steel and Coal Company, Limited, and a similar gear has been erected at the Brook Pit, Heckmondwike. These electric winding-installations have now been at work for some time, and are giving every satisfaction.

At the Heckmondwike colliery, a large fault or throw occurs about 3,000 feet away from the pit-bottom. This fault throws down the coal-seam a vertical depth of 180 feet below its original level. To win the coal-field on the dip-side of the fault, it was necessary to drive either a large drift or sink a staple. If it

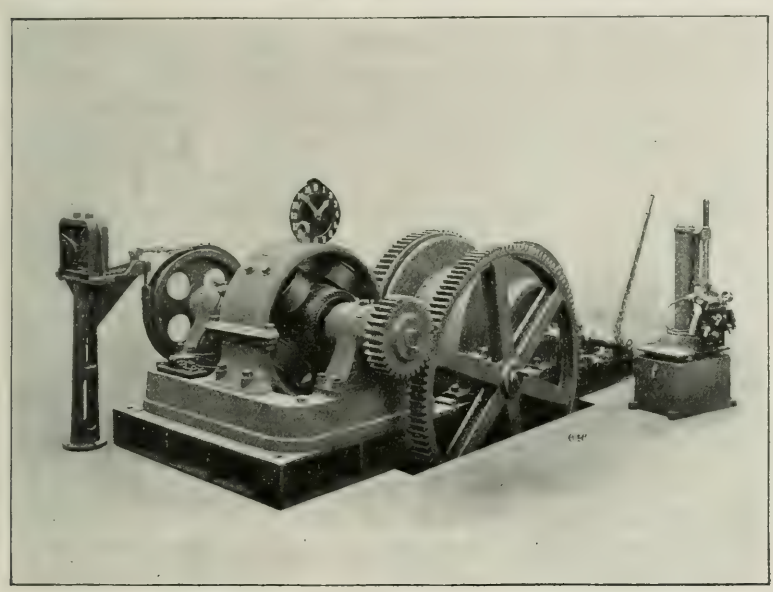


Fig. 14.—Electric Winding-gear for the Shelton Iron, Steel and Coal Company, Limited.

had been decided to drive a drift, it would have been necessary to put down a powerful haulage-plant, at least equal to the size of the present winding-plant. The driving of such a drift, with a gradient of 1 in 6, would have involved 1,080 feet of drifting, and the cost would have been about £1,960. The sinking of the staple cost about £3 10s. per foot for 180 feet, or a nett saving of £1,360 against the drift-scheme. It also took nine months less time to win the coal by the staple than it would have done by the drift.

The shaft is 180 feet deep, and, with the present arrangements, the winding-gear is capable of raising from 150 to 200 tons per day of 10 hours. The winding drum is 3 feet in diameter, and a wind is made in 40 to 45 seconds, equal to a speed of, say, 300 feet per minute. The electric motor, driving the drum, is of the series-wound continuous-current type, capable of working up to 40 effective horsepower, when running at a speed of about 500 revolutions per minute. The motor is fitted with slotted-drum armature, with a specially large commutator fitted with carbon-block brushes, self-oiling bearings, and is of the usual type that the author's firm have designed for this class of work. A machine-cut pinion of forged steel is fitted on the end of the spindle, and gears into a spur-wheel on the countershaft. The first-motion gearing is machine-cut forged steel, and the second-motion gearing is machine-moulded cast-iron. A powerful foot-brake is provided for the drum, operated by a foot-lever. As a further protection, this gear is fitted with an electric brake, very similar to those on the German gears already described. This brake is fitted on the motor-shaft, and comes into operation as soon as the current is switched off, and thereby sustains the load. An indicator is also fitted on the winding-gear to shew the position of the cage in the shaft.

This winder is operated by means of a liquid controlling-switch, arranged for reversing and speed-regulation. The plates are arranged to dip into the liquid in an opposite manner to those of the gear at Preussen II. colliery, in which the liquid rises up the plates. This winder could have been fitted with a three-phase motor of the same power: in which case a similar type of liquid starter would have been employed.

The author hopes that this paper will be of general interest to the members, and afford some idea of the extent to which electric winding-gears are in use in this country and on the Continent. The large winding-gears, which the author saw in Germany, struck him as being put down somewhat on an extravagant scale, and while he would not advocate such elaborate and expensive gears in this country, he quite recognizes (as before stated) that every case must be considered on its own merits. He cannot, however, help thinking that a study of this problem, as it has been treated electrically, would well repay colliery-engineers in Great Britain.

The PRESIDENT (Mr. W. O. Wood) said that the members were indebted to Mr. Mountain for his excellent and instructive paper. He thought that less elaborate and less expensive arrangements might have been found quite as satisfactory, but German certainly set an example to British engineers worthy of being followed in several respects. The economy resulting from electric winders was high, but he would have expected to find that the direct application of steam would have been more economical than through an intermediary power.

Mr. T. E. FORSTER said that one naturally looked at the economical side of the question, and he was afraid that they were rather wedded in this country to commercial enterprise; but, if by spending money, they could save money, it was worth while for everyone to consider the matter. He would like to know whether water was pumped at the Zollern II. colliery, as in addition to winding and ventilating machinery, the paper only referred to the power required for driving the air-compressors and a coal-washery. It was stated that duff-coal was used; perhaps the writer could state what was the nature of this coal, as some people might include nuts and small coal in that category. The coal-consumption appeared to be low, although he believed that there were collieries in this country and in this district with as low, or a lower, consumption. He asked whether by applying electric power a larger output could be obtained from the same shaft; and remarked that possibly, at the German mines, they were not drawing so much mineral as at some of the winding shafts in the Midland district.

Mr. A. L. STEAVENSON said that the question of electric winding was one which might be considered, either from the point of view of economy of power or cost. They began with a given quantity of steam, and if they chose to have a first-class winding-engine (compound, condensing, and fitted with various arrangements which tended to reduce the consumption of steam), it was difficult to see how they were going to turn the steam into electricity, and again electricity into power, with more economy than they could directly use the steam in a first-class winding-engine. Take the case of a motor of, say, 350 horse-power applied to a first-class winding-engine; how much less coal would be required when using electric power as an inter-

mediary? So far as the machinery described was considered as a working machine, it seemed to be perfect, and the work done was, they were given to understand, of a very high-class character: but, if it was an advantage to turn steam into electric power, where were they going to stop? They might use the electric power to compress air, and then use the compressed air as a source of power. He asked, therefore, why it was better to use electric power, rather than to use steam direct, if in both cases a first-class engine was used. His impression was that all subsidiary engines, of which there were generally eight or ten at a colliery, might be driven by electric power by cable owing to its great economy as compared with steam by steam-pipes: but in the case of the large engines employed for winding and pumping, he was inclined to doubt whether the intervention of electric power would prove economical.

Mr. T. W. Benson, referring to the application of electric power for winding up a staple, a long way in-bye, where there was a large downcast fault, said that in cases such as this, where steam could not be possibly used, the use of electric power would be a great advantage. Even with compressed air, there was a great waste of power, owing to the leakage of pipes, etc.

Mr. J. G. Weeks, referring to the statement that the consumption of coal was 2½ per cent. of the output at the Zollern II. colliery, asked whether much water was pumped: whether there was an extensive system of haulage: and finally, whether it was a new colliery, where there was less necessity to use much power. He supposed that the 2½ per cent. did not include coals supplied to workmen or for like purposes, and that it only included the coal-consumption at engines or boilers for power and electric lighting.

Mr. W. C. Mountain replied that the Zollern II. was an absolutely new colliery, at present winding from a seam at a depth of 984 feet and that the ultimate depth would be about 3,000 feet. There were no pumps just now. The maximum speed of winding was limited to 64 feet per second, and he mentioned that figure in his paper with a view of inviting criticism. He found that, in Germany, winding at deep pits was done at a much slower speed than usual at deep pits in this country. At one

of the principal collieries, provided with a high-class steam winding-engine, drawing from a depth of 1,500 feet, a wind was made in about 1 minute, and the changing of the tubs required $1\frac{1}{4}$ minutes, or a total of $2\frac{1}{4}$ minutes per wind, although 25 men were employed at the pit-head to handle the output of 1,100 tons per day. He was informed that £500,000 had been spent on the total equipment of the Zollern II. colliery, and of this amount £125,000 had been spent on machinery in the power-house; and the utmost production was 3,000 tons in 16 hours, from a depth of 984 feet. This power-house had stained-glass windows and a domed glass-roof, and the floor was covered with tesselated tiles.

In discussing the economy of electric winding, people were apt to compare high-class compound or triple expansion engines producing electricity with antiquated steam "eaters," but to strike a true comparison it was necessary to consider the use of compound condensing winding-engines and to compare the results with compound or triple expansion engines producing electricity. Where steam was applied to winding-engines, within 100 or 150 feet of the boilers, he (Mr. Mountain) was doubtful whether any economy could be obtained by the intervention of electric power particularly when three-phase machinery was used, as at Preussen colliery. But a cheap source of power, such as the waste-heat from coke-ovens or blast-furnaces, might be used to generate electric current at a high pressure, at a central station, and thence it could be supplied to adjacent collieries. In such a case, electric power for winding, undoubtedly, had useful and economical applications. At Zollern II. colliery, the motor constantly absorbed only 300 horsepower, and the winder was taking a varying power from it, varying from nil up to 1,500 horsepower: consequently, if the constant steady load of 300 horsepower could be generated economically, the engine would do the work in an economical manner. It was the only economical system of electric winding that he had seen in Germany.

The coal used for firing would probably pass through about a mesh of $\frac{3}{8}$ inch.

Mr. Henry White asked how long the electric winders had been in use at the Preussen and Zollern collieries; whether any

difficulty was experienced in starting the motor or on arrival at bank; and whether any accidents or other difficulties had been experienced.

Mr. W. C. Mountain replied that the electric winder had been running at the Zollern II. colliery, he believed, for only a few months, and the winder at the Preussen II. colliery was also practically new. He believed that there were about 30 electric winders in use in Germany. At Essen, an electric winding-plant had been installed, the power being derived from a public supply-company.

The President (Mr. W. O. Wood) moved that a vote of thanks be accorded to Mr. Mountain for his paper.

Mr. J. G. Weeks seconded the resolution which was cordially approved.

SOME SILVER-BEARING VEINS OF MEXICO.

*(Concluded.)**

By EDWARD HALSE.

Real of Sultepec, State of Mexico.

According to La Croix,† the historian, the first mines worked by the Spanish *conquistadores*, who were guided, no doubt, by the surface-workings of the Aztecs, were those of Sultepec, Tasco, Tlapujahua and Pachuca. The Spanish workings are said to date from 1522, or two years only after the conquest. Alexander von Humboldt, in his essay on New Spain, states that from 1785 to 1789 there was put into the Royal Treasury, from the mines of Tasco, Zacualpan and Sultepec, silver to the amount of 7,806,472½ ounces troy, a quantity exceeded only by the classical districts of Guanajuato, Catorce and Zacatecas.

Sultepec was formerly called "Provincia de la Plata," and it has been recorded officially by José Vincente Cosío,‡ a miner of the district, that in 1802-1804, and 1806-1808, or in all about 4½ years, 1,568 bars were remitted to the city of Mexico from the Real of Sultepec, weighing 1,512,274½ ounces troy, or an average of 336,061 ounces per annum. Of these bars only one was from smelted ore, the remainder having been reduced by the *patio* process.

Towards the close of the eighteenth century, Juan López de Saavedra acquired a large fortune in these mines; he organized the "Compañia Minera Saavedra y Socios," which is said to have extracted the large quantity of silver noted above. Saavedra died in 1806; a few years later, or in 1810, the long War of Independence was commenced, most of the mines were then practically deserted, being left to the tender mercies of

* *Trans. Inst. M.E.*, 1900, vol. xviii., page 370; 1901, vol. xxi., page 198; 1902, vol. xxiii., page 243; and 1902, vol. xxiv., page 41.

† *Historia de Mexico*, pages 41 and 146.

‡ *Diario del Imperio*, No. 440, Mexico, 1866.

the *buscones*,* and it is only within recent years that attempts have been made to work the principal veins on anything like an adequate scale.

The country-rock consists of argillaceous, aluminous and micaceous schists of Lower Cretaceous age, dipping flatly to the south, and striking a few degrees north of east, or obliquely to the *cordilleras* which trend north-west and south-east. To the north, east and west, recent eruptive rocks predominate, consisting of granite, andesite and basalt, but in a southerly direction the belt of slate is traceable for many miles. As pointed out by Mr. Santiago Ramirez,† the schistose area is in fact surrounded by a ring of igneous rocks in the shape of a horseshoe, Temascaltepec and Zacualpan being at its north-western and south-eastern extremities respectively, while Sultepec lies in the centre.

The schists to the east rest on a spur of the great extinct volcano Nevado de Toluca or Xinantecatl (altitude 15,898 feet) the mass of which is built up of hypersthene-andesites;‡ and the Toluca valley; and the surface, for some considerable distance to the west, is covered by andesitic tuffs and breccias.

A few miles north-west of the town of Sultepec, near the Indian village of Santiago Texcaltitlan, are two small extinct volcanoes, with their craters well-preserved, resting on Cretaceous limestone, which is much broken and metamorphosed. These are regarded by Mexican geologists as satellites of the large volcano.

Here and there, patches of limestone are seen lying on the schists. The former is sometimes overlain by Tertiary

* "Those who search for ore in abandoned mines, or who give notice of it in order to obtain a reward."—J. F. Gamboa, *Comentarios á las Ordenanzas de Minería*, Madrid, 1761. It is derived from the verb *buscar*, to search. Closely related are the *rebotalleros*, who restrict their attentions to mine-dumps. By the term *gambucino* is generally understood one who searches for ore generally on his own account; he is in fact the *buscador* of the Spanish, the *faizquiero* of the Portuguese, and the *prospector* of the Anglo-Saxon race. Very nearly allied are the Spanish-American terms *barequeros* (*mazamorreros*, *burbuseros* or *gurgueros*, searchers of alluvial), *cateadores* (or *cateros*, Mexican *pintistas*), *rumbeadores* (searchers of veins), and *monteadores* (searchers of mines in forests and mountains). The *fossicker* of the United States, the *hatter* of New Zealand, and the *pig-rooter* of Australia, are cousins-german of the above.

† *Noticia de la Riqueza Minera de Mexico*, 1884, page 502.

‡ "Bosquejo Geologico de México," *Boletin del Instituto Geológico de México*, Nos. 4, 5 and 6, page 162.

andesites, which have partly altered it, as in the instance quoted above. Dykes and masses of basalt occur here and there, of more recent date than the andesites.

The schists are traversed by metalliferous veins, as well as by quartzose and felspathic igneous dykes, mostly andesitic, which often form one wall of the principal veins for considerable distances. When the dykes leave the lodes, the latter are usually barren, or of very low-grade value.* Hence, although the dykes are probably of more recent age than the principal fractures, the filling (as regards the silver-contents) is undoubtedly related to them.

The veins may be grouped as follows:—(1) North-west to south-east veins, dipping usually north-eastward 60 degrees. These are the principal veins, and the only ones that have been worked to any extent hitherto. (2) East-and-west veins, dip variable, (3) north-and-south veins, cutting across (1) somewhat obliquely, dip generally eastward.

The powerful outcrop of one of the principal veins of the district is traceable for upwards of $\frac{3}{4}$ mile; it then throws off a large branch to the east, while the main vein or leader can be traced for some distance farther south. This vein is on an average upwards of 60 feet thick: the schistose country is often highly metamorphosed near the vein, being changed in places into quartz-rock. The alteration has doubtless been effected by the dyke which generally accompanies the vein, as well as by the thermal waters emanating from the latter.

The ores of the vein consist of iron-pyrites (*bronce*), marcasite, argentite, ruby-silver (pyrargyrite and occasionally proustite), stephanite (rare), miargyrite ($Ag_2S.Sb_2S_3$, rare) and blende. The veinstone consists of white crystalline quartz, amethystine quartz, calcite, dolomite, brown spar, fluorspar and heavy spar (rare). The non-silver-bearing heavy minerals are copper-pyrites, stibnite (rare) and mispickel. Near the surface, native silver in fine threads and leaves, associated with gypsum, horn-silver and argentite, is sometimes disseminated in oxides and

* *Distrito y Real de Minas de Sultepec*, Mexico, 1888, page 14, an official report by Mr. Bartolomé Teodoro Villanueva. In Real del Monte, Hidalgo, the Moran vein (strike east and west, dip northwards) accompanies the dyke known as San Esteban, but the vein is, on the whole, of low-grade value.

hydroxides of iron, copper and manganese, constituting what Mexican miners term *ixtajales*,* an earthy variety of gossan.

Sometimes the structure of the veins is brecciated, but more often the ores and gangue are arranged in layers parallel to the walls: the banded structure, however, is not symmetrical, for one or more bands (*fajas* or *cintas*) of mineral may be succeeded by more or less barren layers (*bancos*) of country-rock: sometimes ore and matrix occupy the whole width of the vein, or ore, matrix and country-rock may be so intermixed that the filling is confused, and no definite structure can be made out.

According to Mr. Villanueva,† wide cavities occur here and there in the veins, filled with nodules of iron-pyrites, blende and galena mixed with quartz, which are coated with calcite or siderite (*espato ferrífero*). These may be compared to the cockade-, sphere- or ring-ores of some European regions, although in the latter, fragments of earthy veinstone or country-rock generally form the nucleus, the surrounding layers being composed of metalliferous minerals. The same author states‡ that when the gangue consists largely of fluorspar, mixed with brown spar and limonite, galena is abundant and contains a high percentage of silver; whereas an increase of quartz in the vein is followed by an increase in blende and a diminution in galena, the percentage of silver in the latter decreasing also. It would appear, from the above, that open spaces existed here and there in the vein, which have subsequently been partly or wholly filled by ores, gangue and rock: but there is no doubt that a considerable portion of the filling has been produced by replacement or substitution.

The walls of the principal veins of the district are without selvages, and are frequently ill-defined. The barren filling consists usually of schist, generally altered, sometimes being highly quartzose (quartz-rock), and sometimes decomposed to a white clay (kaolin).

The ores, as a rule, are adapted to smelting, and unsuitable for treatment by the *patio* process. The Spaniards treated

* *Informe Provisional del Ingeniero Bartolomé T. Villanueva* . . . Mexico, 1888: compare *Trans. Inst. M.E.*, 1901, vol. xxi., page 206.

† *Distrito y Real de Minas de Sultepec*, page 12.

‡ *Op. cit.*, page 14.

only the docile ores, leaving the leady and pyritic ores untouched. They may be divided into:—(1) *Metales secos* (German *Dürrerze*), dry ores, or those with insufficient lead for smelting purposes. In these ores are included the silver-minerals, together with oxide of iron, etc., and a certain proportion of gold. The richer ores are smelted with (2) and (3), while the poorer ores are generally first roasted in kilns; (2) *ligas* or *metales plomosos, de fundición* or *de fuego,* leady or smelting ores, or those containing a good proportion of galena. The latter mineral is usually of coarse grain and poor in silver, and is known in the district as *soroche*;* (3) *metales piritosos* or *de quema*, pyritic or roasting ores, or those chiefly consisting of iron-pyrites and blende,† which are usually roasted before being smelted with (1) and (2). These ores are generally silver-bearing, and the iron-pyrites often contains gold as well.

The veins of the Malacate mine, one of the most important in the district, are shown in Fig. 1 (Plate VIII.). The relative positions and directions of these are, however, approximate only. The San Pascual lode, which forms a part of the master-lode already mentioned, strikes north 48½ degrees west to south 48½ degrees east. This and the Concepción, which is probably an accompanying quartzose dyke, strongly metalliferous in places, dip north-eastward 60 degrees for a vertical depth of 195 feet, then the lodes become much flatter, the dip being north-eastward 35 degrees for a further vertical depth of 120 feet, below which both lodes appear to resume their normal dip (north-eastward 60 degrees). The average combined thickness is about 50 feet.

Judging by the old workings, the ore has a tendency to pitch to the south-east. The pitch of the ore-bodies was most probably determined by the dip of the schistose country, which is southerly. The longitudinal section of the mine-workings shows two ore-shoots. The western one pitches south-eastward

* In Zacatecas, *soroche plomoso* is carbonate of lead, and *soroche reluciente* is argentiferous galena. According to Mr. J. B. Guim (*Nuero Diccionario de la Lengua Castellana*, second edition, Paris, 1864), *soroche* in Spain is "mineral reluciente y quebradizo que tiene alguna plata, y puede reducirse á la clase de los negrillos." The same author describes *negrillo* as a miner's term for a variety of black native silver.

† As much blende as possible must be got rid of by hand-picking, and by concentration, as it is harmful in the smelting process.

30 degrees, and was worked by the Spaniards for a length of 70 feet (measured across the pitch) and to a depth of 140 feet (measured along the pitch). The second ore-shoot, 110 feet to the east (measured horizontally) pitches south-eastward 38½ degrees, and was worked by them for a length of 50 feet and a depth of 350 feet. This depth is much greater, if we include some old workings on a higher parallel ridge.

The writer has already pointed out* how necessary a knowledge of such local laws of ore-deposition is, in order to develop the veins in a rational manner. In estimating the probable reserves of ore, too, its occurrence in shoots must clearly be taken into account, and the unproductive ground between them must be eliminated from any estimate of the probable ore-reserves in depth.

The general structure of the San Pascual vein is seen in Fig. 2 (Plate VIII.). The iron-pyrites in the veins is usually fine-grained; the matrix consists of quartz, calcite (often in geodes), heavy spar and kaolinized country-rock. The silver-ores proper usually occur on the foot-wall. The bands, layers or streaks are frequently separated from each other by "horses" of country-rock (*caballetes* or *tabiques*), or by practically barren vein-filling; and sometimes the ores (leady with streaks of dry silver-ores) are continuous from wall to wall for a thickness of 30 feet and upwards. As a rule, the ore-streaks are of good workable size, varying from 2 to 4 feet and upwards in thickness.

The Concepción lode runs for some distance alongside the last in yellow schistose country-rock, and then branches off from it. The metalliferous contents are much the same, but the vein-stone, where the lode is ore-bearing, contains very little quartz, and much crystalline calcite, as well as some fluorspar. The ores are dry and leady. As the lode contains a large amount of calcite, the filling is probably of more recent date than that of San Pascual. La Concepción is probably a subsidiary fracture which has been formed on the lying or foot-wall side of the San Pascual vein: a few other smaller and less-defined parallel fractures occur to the south. The above may be compared to the branches that occur on the foot-wall side of the large veins of

* *Trans. Inst. M.E.*, 1901, vol. xxi., page 209.

the region of Taviches,* Oaxaca, as well as to those occurring in Zacatecas,† and in the *veta madre* of Guanajuato.‡

The two veins, as cut by the Santa Helena tunnel to the west, have the structure shown in Fig. 3 (Plate VIII.). The pay-streak, *a*, occurs on what appears to be the foot-wall of the San Pascual vein; La Concepción is represented by a thick band of hard mineralized quartz-rock of low-grade value, *d*: in fact, at this point, the dyke (if it be such) is practically non-metalliferous.

The Capulin vein runs nearly east and west, but it would appear to be an eastern branch of the San Pascual lode, for it has not been traced to the west of the latter. It has a southerly dip at and near the surface; but, where it forms a junction with the San Pascual and Concepción, it follows the general northerly dip of these lodes. The structure is shown in Fig. 4 (Plate VIII.). In this instance, the high-grade ore, *a*, occurs on the hanging-wall. The foliated iron-pyrites, *b*, is sometimes stained with copper. In one place on the hanging-wall, there is a band of oxide of iron bearing free gold and no silver. This vein is characterized by having little or no galena and blende.

Prof. Edmund Fuchs§ describes Capulin as formed of three or four veins close together, which are sometimes united by oblique veinlets or by a pyritic impregnation. These so-called "veins" are probably identical with what are termed, in this paper, bands, layers or streaks.

The Providencia is a parallel vein, some distance to the north of San Pascual; but the dip is south-westerly, and the vein is non-auriferous. The thickness varies up to 14 feet, the best ore being from 4 to 6 feet of iron pyrites in coarse cubical crystals, which carries up to 80 ounces of silver per ton. It also contains some silver-ores (native and ruby-silver), galena and blende: the gangue is quartz and crystalline calcite. The country-rock is a blackish schist stained with copper.

Just above the Guadalupe river, to the north-west of the Malacate ridge, a powerful vein is seen to strike straight into

* *Trans. Inst. M.E.*, 1900, vol. xviii., page 384.

† *Ibid.*, 1902, vol. xxiv., pages 42 and 43. ‡ *Ibid.*, 1902, vol. xxiv., page 51.

§ *Traité des Gîtes Minéraux et Métallifères*, Paris, 1893, pages 826 and 827.

the hill, or south 70 degrees east, dipping north-eastward 63 degrees, and traceable for a height of 500 feet. The proved thickness in one place is 20 feet, and the lode is said to be spotted throughout with argentite.* On the opposite bank of the river is an escarpment of columnar porphyritic rock, which no doubt cuts the vein off in that north-westerly direction.

One of the north-and-south cross-veins (French *croiseurs*), known as the Veta Nueva, is described by Prof. Fuchs† as attaining a thickness of 16½ feet. It contains galena, cerussite and iron-pyrites, all silver-bearing. Its greatest richness is concentrated towards its intersection with other veins.

Several *vetas ocultas* or "blind veins" (having no visible outcrops‡) have been met with in the underground workings. One of these trends north 60 degrees west to south 60 degrees east, and dips north-eastward 45 degrees. The structure is represented in Fig. 5 (Plate VIII.). The rib of quartzose ore, *a*, on the hanging-wall is 18 inches thick; but the pay-streak proper consists of only 3 inches of native silver and argentite. The rib on the foot-wall, *b*, is composed of 18 inches of iron-pyrites (gold- and silver-bearing) with quartz and calcite. The two streaks are separated by a band of country-rock, *c*, *in situ*, 25 feet thick, bespattered throughout with sulphides. Some of the so-called "blind veins" are doubtless nothing but local impregnations of the schistose country-rock.

The Socabon Grande, 600 feet above the Guadalupe river, and about 500 feet below the lowest workings of the Malacate mine, was driven into the hill by the Spaniards in a southerly direction for a length of upwards of 1,738 feet. The tunnel followed a cross-vein (north and south) for some distance, and several subsidiary veins were cut, but it falls a long way short of the principal veins. It is an interesting fact that the water from the upper workings here makes its way into the adit through a natural fissure in the rock.

Although rich patches of ore occur here and there in the veins, the contents, as a rule, are not of high-grade value, the

* The workings were under water at the time of the writer's visit.

† *Op. cit.*

‡ Known to the Mexicans as *filones sin crestones*.

average amount of silver in the ore-bodies not exceeding probably from 20 to 30 ounces of silver per ton. The gold is very irregularly distributed in the ores, but averages from 3 to 4 dwts. per ton.

The great drawback to the district is the want of a railway. A time is perhaps not far distant when Sultepec will be connected with the narrow-gauge National Railway at Toluca, which lies about 50 miles to the north-west. In this case, coke will replace the charcoal used in the water-jacket furnaces, and the district will doubtless become an important smelting centre.

There is a group of silver-bearing veins immediately to the south-east of the town of La Unión, which may be considered apart. The general strike is north-west and south-east; the veins are comparatively thin, averaging from $2\frac{1}{2}$ to 5 feet in thickness. Native silver is fairly abundant in these veins, and, according to Mr. Villanueva,* the average value of the ores ranges from 39 to $242\frac{1}{2}$ ounces troy per short ton of 2,000 pounds.

In the same district are parallel veins carrying argentiferous galena; these are much wider, being from 16 to 20 feet in thickness. One vein, indeed, known as the "Salon," from the enormous cavities which have resulted from the former workings, has a minimum thickness of 39 feet, and carries galena in large isolated masses mixed with iron-pyrites and blende. These ores yield on an average 20 per cent. of lead, and from 39 to $48\frac{1}{2}$ ounces of silver per short ton.†

Farther north-east is another group of silver-bearing veins proper, which, like the first, are thinner than those bearing lead. The ore consists of double sulphides of silver, antimony and iron, sometimes accompanied by blende. The average silver-contents vary from $48\frac{1}{2}$ to 97 ounces per short ton.‡

Pachuca, State of Hidalgo.

As Pachuca can be reached in a few hours by rail from the city of Mexico, it is probably more visited by foreigners than any other mining-camp in the Republic. It is famous historically, for the workings date from 1522; and in 1557 Bartolomé de Medina invented here the well-known *patio* or

* *Op. cit.*, pages 29 to 35. † *Op. cit.*, page 35. ‡ *Op. cit.*, page 37.

cold-amalgamation process. It is famous, too, for the depth and modern equipment of its mines. Indeed a few years ago, Pachuca was the most important silver-producer in Mexico, but in December, 1895, a disastrous inundation took place in the principal workings of the Vizcaina vein, which has considerably retarded development. Large pumping-plants have been installed in order to drain the flooded workings, and it is to be hoped that the district will in the near future regain its old supremacy.

So much has been written about Pachuca, notably by Messrs. Humboldt, Burkart, H. G. Ward, L. De Launay, von Groddeck and P. Laur, and quite recently by Messrs. J. G. Aguilera and E. Ordoñez,* that it would be a superfluous task to describe the district in anything like detail. Consequently, the writer will give only a general sketch of Pachuca, and point out the main characteristics of the veins.

The Pachuca range of mountains, a branch of the eastern chain of the Sierra Madre, which tends approximately north-west and south-east, the two districts of Pachuca and Real del Monte being on its western and eastern slopes respectively, is built up of Tertiary eruptive rocks, andesites, dacites, rhyolites and basalts, which have been erupted in the order named. At Regla, north-east of Real del Monte, columnar basalt rests directly upon altered and greatly contorted beds of calcareous sandstones, argillaceous and marly slates, with some layers of limestone. These beds are regarded as of Upper Cretaceous age.

The country-rock is essentially an altered pyroxene-andesite, which was known to the older writers as "metalliferous porphyry." Frequently the andesite is highly quartzose, forming dacite; and, here and there, it contains much amphibole, becoming hornblende-andesite. The normal type is a green, highly porphyritic compact rock with no particular structure: the country-rock (*panino*), however, is generally dark-coloured, and arranged in thin layers or sheets (*lajas*), which are more or less vertical, and usually parallel to the general direction of the veins. Near the latter, the rock is nearly always bespattered with small crystals of iron-pyrites, which bears little or no

* "El Mineral de Pachuca," *Boletin del Instituto Geologico de México*, Nos. 7, 8 and 9, 1897. The writer is largely indebted to this memoir for the facts recorded in the text of his paper.

silver; while the same mineral in the veins is usually in crystalline aggregates, is nearly always silver-bearing, and sometimes to a considerable extent. For instance, according to Mr. C. B. Dahlgren* the iron-pyrites of the San Pedro mine was found to contain as much as 495 ounces of silver per ton.

The rock is frequently highly altered to some considerable distance from the veins, silicification, kaolinization, and other metasomatic processes often masking its real nature. According to Mr. Leopoldo Salazar† it is difficult to meet with unchanged rock, even 130 feet from the Vizcaina or mother-lode of the district, owing to the number of small veins that run parallel with it. The pyroxene is frequently altered into chlorite and epidote, the felspars (oligoclase and labradorite) into calcite, epidote and quartz, as well as into kaolinite (*arcilla*). Mr. Waldemar Lindgren says "on the whole, the similarity of this district to the Comstock, so far as the alteration is concerned, is very striking; and there is little doubt that the two deposits owe their origin to extremely similar solutions."‡

The veins of Pachuca are referred to one east-and-west system of fractures only.§ There are secondary veins branching off from, and sometimes diagonally uniting, the east-and-west parallel veins at angles seldom exceeding 30 degrees (Fig. 7, Plate VIII.). The veins are remarkable for their persistence in length. The Vizcaina or mother-lode can be traced for about 10 miles, and other veins are visible for considerable distances, but the thickness seldom exceeds 23 feet. According to Mr. Dahlgren, the Veta Vizcaina has a thickness of 16 feet, but the average thickness of all the principal veins would probably not exceed from 6 to 8 feet. The veins are pretty regular as regards strike, but they are frequently split up into branches, which unite again farther on. These branches may occur on either wall of the main fracture, and sometimes form, as seen in plan, arcs of great radius: this is particularly noteworthy in Los Analcos (Fig. 7, Plate VIII.).

* *Minas Historicas de la Republica Mexicana*, Mexico, 1887, page 200.

† *Estudio de la Veta Vizcaina en la parte que se explota en las minas San Rafael y Anexas*, Mexico, 1895, page 11.

‡ "Metasomatic Processes in Fissure-veins," *Trans. Am. Inst. M.E.*, 1900, vol. xxx., page 650.

§ In Real del Monte, newer north-and-south veins do occur, and are termed *trasversales*, to distinguish them from the east-and-west veins known as *legítimas*.

Some of the veins have a distinct outcrop of quartz, either more or less pure, or carrying pyrites, and its derivatives limonite and earthy peroxide of iron, as well as pyrolusite. In some veins no outcrop is visible, and they are only traceable by bands of highly silicified or kaolinized andesite, carrying some thin veins of quartz, occasionally alternating with calcite.

The general dip of the veins is southerly,* but very irregular, varying from 35 degrees to vertical. Changes in the dip are frequent, much more so than is the case in Real del Monte. The average dip of the principal veins is about 66 degrees. Among the exceptions may be mentioned the Cristo vein, which is vertical at and near the surface; the dip then changes to north 63 degrees. In the San Rafael mine, the Veta Vizcaina dips generally southward 72½ to 87 degrees, but in places it is vertical, or dips northward up to 79 degrees. Mr. Salazar† points out that the more vertical portions of the lode carry the riches. This empirical rule has notable exceptions, even in Pachuca. Thus the Veta de los Analcos has one remarkable inflection, the dip changing suddenly from 38 to 84½ degrees: the rich zone occurred in the flat portion of the vein above the steep bend. Again in the Bartolomé Medina vein the dip changes abruptly from 35 to 53 degrees, and the riches were found in the upper flatter portion of the vein.

The ores consist of iron-pyrites, fine-grained galena and argentite, together with some copper-pyrites, blende, stephanite ($5Ag_2S.Sb_2S_3$) and polybasite ($9Ag_2S.Sb_2S_3$). Of these latter minerals, copper-pyrites is somewhat scarce, and generally appears only in depth. Blende is infrequent, having a tendency to increase in depth, while stephanite and polybasite sometimes occur in depth below the *negros*, or simple sulphides, as a subzone associated with galena, iron-pyrites and some argentite. The iron-pyrites of the veins is always silver-bearing, galena less so, while the blende and copper-pyrites only occasionally carry silver.

The matrix consists largely of milky quartz with a greasy

* This is the rule also of the east-and-west veins of Real del Monte; the Moran vein is one exception, the dip being northerly.

† *Op. cit.*, page 17. This applies also to the veins of Real del Monte.

lustre, or it is bluish or chalcedonic, or in the form of agate, or amethystine. Calcite is not common, it has a tendency to diminish in depth, and, as in most districts, it appears to be the last mineral formed. Siderite is occasionally found, as well as dolomite—the latter usually crystallized on amethystine quartz. Manganese as rhodonite (silicate) and sometimes crystallized in geodes as rhodochroisite (carbonate) occurs not infrequently at various depths below the oxidized zone. Thus in the San Rafael mine, at a depth of 820 feet, the gangue (quartz and some calcite) is accompanied by rhodonite,* and its variety bustamantite. In the Santa Gertrudis mine, barytes has been met with at a depth of 500 feet, associated with quartz and calcite.

The rare or accidental minerals, most of which are of secondary origin, are comprised in the following list:—Arragonite (El Rosario mine), valencianite (a variety of orthoclase), apophyllite (Guadalupe and El Rosario), and its variety xonotlite ($4CaSiO_3 + H_2O$, Guadalupe), mountain-cork (a variety of asbestos, El Bordo), alabandite (MnS, El Rosario), massicot (PbO), vanadinite (a vanadate of lead, San Antonio and El Puerco), and pyromorphite (a phosphate of lead, Manzano). Native copper occurs in small quantities in the San Rafael mine at a depth of 1,148 feet. It has also been found in some of the upper levels of the same mine, together with the silicate (chrysocolla) and carbonate (malachite). When the ore has a greenish stain due to copper it is said to be *acardenillado*, and this is regarded as a favourable sign.

Quite remarkable is the absence of ruby-silver. Mr. E. Ordoñez says that it has never been found in the Pachuca veins,† but in the catalogue of minerals compiled by Mr. Aguilera‡ dark ruby-silver or pyrargyrite ($3Ag_2S.Sb_2S_3$) is given as having been found in no less than 21 mines of the district, and is also recorded as having been found in Real del Monte. Light ruby-silver or proustite ($3Ag_2S.As_2S_3$) appears to be entirely absent in

* In the Santa Cruz vein of Real del Monte, which runs north and south and dips eastward, rose-red rhodonite frequently forms part of the veinstone in the bottom levels (depth 1,568 feet in 1895). The principal ore-body has a length of 656 feet, and is from 12 to 20 feet wide.

† "The Mining District of Pachuca, Mexico," *Trans. Am. Inst. M.E.*, 1902, vol. xxxii., page 238, and also the memoir already quoted.

‡ "Catálogo sistemático y geográfico de las especies mineralógicas de la República Mexicana," *Boletín del Instituto Geológico de México*, 1898, No. 11, page 62.

both districts—at least, so far, there is no authentic record of its occurrence.

In Pachuca, as in most of the mining districts of Mexico, an oxidized zone (*colorados*) occurs from the surface down to water-level, and is succeeded by the sulphide-zone (*negros*). Frequently, psilomelane, pyrolusite and wad predominate in the gossan, giving it a black, porous, cinder-like appearance—hence the term *quemazones* (from Spanish *quemar*, to burn), which is applied to this variety of *colorados*. The silver is found in this zone in the native state, or as chloride or chloro-bromide, or as simple sulphide (argentite). Gold usually accompanies the oxidized zone when limonite is abundant. The sulphide-zone is known as *pinta azul*, for the quartzose matrix is frequently of a grey-blue colour, owing to finely disseminated lead and various silver-ores as sulphides. In some veins, as, for instance, La Vizcaina and Santa Gertrudis, the oxidized zone is almost entirely absent, and the *bonanzas* of these mines have commenced only at depths ranging from 350 to 500 feet.* The depth to which the oxidized zone extends varies considerably in different mines, and even in the same mine. In the Santa Teresa mine, it reaches a depth of 70 feet only, while in the Bordo mine oxidized ores go down to a depth of over 984 feet. The two zones frequently overlap—in other words, the *colorados* and *negros* are often found side by side at the same level, the former, as will be seen when considering the structure of the veins, being usually confined to one or both walls.† The sulphide-zone has been worked to depths ranging from 1,000 to 1,300 feet, and, in rare instances, to a little over 1,500 feet, below which is a practically barren zone, characterized by galena and blende bearing little or no silver, in a quartz-matrix.

Judging by the structure, and the presence of selvages on the walls, the veins appear to be of the class known as fissure-veins. Faults are small and few in number in the district, but that considerable movement has taken place in the walls is

* The bonanzas of the Santa Iñés vein of Real del Monte commenced at a depth of 328 feet (300 metres).

† Compare *Trans. Inst. M.E.*, 1900, vol. xviii., page 372, Plate XVIII., Fig. 2. In this instance the gouge of clay on the hanging-wall seems to have prevented oxidation on that side. In Real del Monte, an instance occurs of oxidized ores occupying the centre of the vein along which it has been re-opened, the sulphide-ores being confined to the walls. "El Real del Monte," *Boletin del Instituto Geológico de México*, No. 12, page 19, Fig. 3.

evident—for frequently the quartz and ore next to them are crushed to fine powder, locally called *lamas*,* and forming selvages or *guardas*† which are frequently very rich. Sometimes on the hanging-wall there is a flucan of polished clay with slickensides. The structure of the veins is often banded, the layers of quartz sometimes having geodes, indicating that that mineral has crystallized out in open spaces in the veins: but the banded structure is seldom symmetrical,‡ for it has been interfered with by later re-openings and replacements.

The structure of the Maravillas vein, in one place, at a depth of 328 feet, is as follows:—Hanging-wall, oxide of iron and clay, calcite with quartz, sulphide-ore with a little quartz, amethystine quartz, foot-wall impregnated with ore (sulphides). At a short distance from this section, the amethystine quartz was absent.

In the Cal y Canto vein, there is:—Hanging-wall, quartz with ferruginous oxides and black sulphides, "horse" or band of country-rock, rib of pure quartz, black sulphides and quartz, calcite and fragments of country-rock, quartz with ferruginous oxides and black sulphides, foot-wall. As the writer states in another paper:—"The vein appears to have been re-opened along the centre, and what has the appearance of brecciated structure may in reality be an instance of the partial replacement of the country-rock: for, as a band of ore separates it from the foot-wall, it is difficult to conceive how it could have been produced by movement along that wall without leaving evidences of crushing in the band of ore also."§ Where the same vein is impoverished, at a depth of 722 feet, it consists of several parallel veinlets of sterile white quartz coursing through country-rock (hypersthene-andesite). These are enclosed by walls having selvages of crushed quartz and clay. Sometimes, the filling con-

* In the *patio* process, *lama* is slimes or ore ground into paste by the *tahonas* or *arrastres*. Crushed ore and gangue is still more noticeable in the veins of Real del Monte, and has resulted from reopening (termed *abra* in the district).

† "Se ven las guardas marcando la linea de separacion entre el cuerpo de la veta y la roca en que arma, fortemente impregnado de mineral" (Mr. Santiago Ramirez). *Guardas de arcilla* are salbands, flucans or selvages.

‡ One instance of normal or symmetrical banded structure occurs in the Cabrera vein of Real del Monte, *Boletin del Instituto Geologico de México*, No. 12, page 22, Fig. 7: and also *Trans. Fed. Inst. M.E.*, 1891-1892, vol. iii., Plate LX., Fig. 2. These examples are quoted, as symmetrical structure is rare in Mexico.

§ "Notes on the Structure of Ore-bearing Veins in Mexico," *Trans. Am. Inst. M.E.*, 1902, vol. xxxii., page 301.

sists of quartz and argentiferous sulphides (*azogues* of the miners), separated into bands by veinlets of pure or barren quartz, more hyaline than that of the rest of the filling. Sometimes, the bands of pure quartz are very irregular in shape: then no banded structure has resulted.

Very rarely, the banded structure has a symmetrical appearance: but even then it is very doubtful whether it has been built up by the different layers having been deposited *pari passu* from opposite walls: for the ribs of pure quartz, which help to make up the banded structure, have most probably been formed at a later date than the rest of the filling. The lodes, in fact, would appear in many instances to have been re-fractured in planes parallel to the walls, giving access to siliceous solutions. From these, quartz has been deposited, partly by crystallization in the open spaces resulting from the new fractures, and partly by replacement of the older filling. The veins sometimes have a brecciated structure. In Real del Monte, that is of far more frequent occurrence.

The Santa Gertrudis mine, which had a depth of 1,200 feet in 1895, has been sunk on a vein which runs a few degrees north of east, and dips southward 70 to 80 degrees. As the writer saw the vein in the *bonanza* portion in that year, the filling—often 20 feet thick—was very soft, the ore occurring in bands (*cintas*) or small bunches (*en bolco*), the matrix being quartz of the variety known as "sugar-spar." Two main shoots have been found, which have a tendency to pitch eastward. On the hanging-wall there is usually a layer several inches thick of highly polished blue clay with slickensides, termed "cab"* by the Cornish miners of the district. This wall is very treacherous, for near the lode on that side the rock is strongly kaolinized. The whole of the lode is taken out and timbered up by square sets, spilling or fore-poling sometimes having to be resorted to in stoping and driving. The levels are supported by masonry.

* In Cornwall, *cab* is (1) chalcedonic quartz: or (2) altered granite forming one and sometimes both walls of a tin-bearing lode. According to Sir Clement Le Neve Foster it consists at the Lovell mine of quartz and mica, gilbertite, chlorite, iron-pyrites, copper-pyrites, and a little schorl (common black tourmaline), from 6 to 12 inches thick. In West Cornwall, *cab* is the name of a horny gall on the hand caused by friction (Miss Courtney). When the side of a lode is as hard as flint, Cousin Jack says that it is "cabby."

A remarkable feature of the Pachuca veins is the orientation of the payable ore-bodies. Messrs. Aguilera and Ordoñez* point out that, although the veins course in a general east-and-west direction, the ore-bearing zones are directed north-west and south-east: and that, not infrequently, where one mine has an ore-shoot, the adjoining one will have a barren zone opposite it, so that the *bonanzas* of the different veins almost present an alternating position. This is directly contrary to the empiric rule known among miners as "ore-against-ore" (French *vis-à-vis*). The rule, however, is by no means a general one, for many exceptions occur.

Fig. 6 (Plate VIII.) is a theoretical diagram in which an explanation of this peculiarity is suggested. It is wellknown that in most districts a band of country of moderate hardness and usually of a distinct colour, and favourable for the deposition of ore (known to the Germans as *Erzträger*), is sooner or later succeeded by a band of very hard, or, on the other hand, of very soft country in which the veins are more or less sterile. In Pachuca, it is probable that the alternating bands are directed in a north-west to south-east direction, or parallel to the Pachuca range: consequently, two veins, A and B, which are a sufficient distance apart, will have their ore-bodies alternating *a*, *b*, *c* and *d*, as in the diagram. The two ore-bodies *b* and *d* of the vein A are opposite the sterile ground *f* and *h* of the lode B; while the two ore-bodies *a* and *c* of the lode B are opposite the sterile ground *e* and *g* of the lode A. We may suppose a third vein, C, contiguous to A. In this instance the ore-bodies will be practically opposite each other, or *vis-à-vis*.

Many of the ore-bodies are extremely irregular, having no definite shape and no determined pitch. A few of the largest, however, appear to have a general tendency to pitch to the eastward.† In the Cristo and San Juan Analco mines, this is fairly well-marked, but less so in the case of the Maravillas and Santa Gertrudis mines. In the Bordo mine, the ore is in small, narrow,

* *Boletín del Instituto Geológico de México*, Nos. 7, 8 and 9, page 73. In Mr. Ordoñez's paper, published in *Trans. Am. Inst. M.E.*, vol. xxxii., page 239, the payable zone is said to be oriented from north-east to south-west—this must be a misprint.

† This also appears to be the case with the Veta Vizcaina in Real del Monte. The pitch of the ore-shoots of the principal north-and-south veins (Santa Inés and Santa Brigida) seems to be southerly.

nearly vertical shoots (*clavos*). In the San Rafael y Anexas mines on the Vizcaina or mother-lode, the ore-shoot, worked from the 354½ feet (108 metres) level to a depth in 1895 of 1,230 feet, appears in inclined columns which pitch westward at angles varying from 57½ to 80 degrees, yet these columns may be regarded as forming one long course of ore (1,500 feet measured horizontally) which pitches eastward, or in the opposite direction.*

Frequently the ore occurs in small pockets (*bolcos*) or in little bunches (*ojos*), and sometimes it is scattered throughout the vein in isolated spots known as *moscas*.†

It has not yet been definitely proved here, or indeed anywhere in the Republic, whether a third ore-bearing zone occurs below the impoverished zone. This is a problem that can only be solved by future development.

Mr. Ordoñez points out that in the San Rafael and Maravillas mines, "beyond an impoverished portion, there has immediately appeared native copper with polybasic mineral, blende and notably rich ores (naturally rebellious), showing what would be the mineral composition of the ores of the third zone."‡ The presence of native copper looks as if the above complex ores had resulted from secondary enrichment, due to surface-waters, which have made their way down the lodes, or possibly to ascending thermal solutions. The fact of native silver having been found in another vein at a depth of 820 feet, and of chlorobromide of silver having occurred in depth in the Santa Gertrudis mine, associated with galena and polybasite, seems to point to the same conclusion. Again, according to Mr. S. F. Emmons,§ "in the San Juan region of Colorado, there is a very strong belief held by some of the more experienced and thoughtful mining engineers, that the rich silver-minerals in those veins, such as ruby- and brittle-silver [stephanite], are the result of secondary enrichment by descending waters." . . . At

* See the longitudinal section of the mine prepared by Mr. L. Salazar (*op. cit.*, page 20). In that given by Messrs. Aguilera and Ordoñez, the inclined columns pitching westward are not shown, the whole being coloured red, but the general easterly pitch can be made out.

† Compare *Trans. Inst. M.E.*, 1900, vol. xviii., page 379, for the *metal mosqueado* of the Taviches district, Oaxaca (hornblende-andesite).

‡ "The Mining District of Pachuca, Mexico," *Trans. Am. Inst. M.E.*, 1902, vol. xxxii., page 240.

§ "The Secondary Enrichment of Ore-deposits," *Trans. Am. Inst. M.E.*, 1900, vol. xxx., page 195.

Neihart, Montana, according to Mr. W. H. Weed, "the primary minerals are galena, blende and pyrite; the secondary sulphides are polybasite, ruby-silver, more rarely a pure transparent blende. Under the microscope galena is seen altering to a spongy polybasite. Polybasite and pyrargyrite are seen as crystalline aggregates and crusts on all other minerals, but in no cases coated by other minerals."*

In this connection we may cite Messrs. Aguilera and Ordoñez:—"Pronto se unen á estos sulfuros simples la estefanita y la polybasita íntimamente mezclados con la galena y sulfuros de plata, que se aislan en pequeñas cristales tabulosos en pequeñas geodas."†

It is undoubtedly of good augury for the future development of Pachuca that the veins, although impoverished, are well-formed, and retain their general structure at the greatest depth yet reached (1,653 feet); and that, whatever the later or secondary alterations may have been, the primary filling or enrichment shows evidence of having been produced by thermal and therefore ascending solutions. So far as we know, the above paragraph will apply to other classical districts of the Republic, worked for long periods, such as Real del Monte, Catorce (San Luis Potosí), Zacatecas and Guanajuato, where the greatest depths reached are 1,568, 1,600, 1,700 and 1,968 feet respectively.

CORRECTIONS AND ADDITIONS.

Region of Taviches, Oaxaca:—Trans. N.E. Inst., 1900, vol. xlix., page 113, 2 lines from the bottom *for* "an amygdaloidal structure," *read* "a brecciated structure."

Tasco, Guerrero:—Trans. N.E. Inst., 1901, vol. l., page 202, line 15, *after* "modern eruptive rocks," *add* "the veins of Tasco, according to Mr. J. G. Aguilera are related to andesite and rhyolite."†

Santiago Papasquiero and San Dimas, Durango:—Trans. N.E. Inst., 1902, vol. li., page 178, line 10 from bottom, *for* "silification" *read* "silicification"; and page 182, lines 7 and 8, *for* "(? in the same district)" *read* "in the same district."

Zacatecas and Guanajuato:—Trans. N.E. Inst., 1902, vol. lii., page 40, line 18, *for* "Upper Tertiary (Pliocene)," *read* "Miocene or Lower Pliocene."

* *Trans. Am. Inst. M.E.*, 1900, vol. xxx., page 196.

† *Op. cit.*, page 70.

‡ "Distribution of the Mineral Deposits of Mexico," *Trans. Am. Inst. M.E.*, 1902, vol. xxxii., page 514.

The red conglomerate of Zacatecas is Miocene; that of Guanajuato, Lower Pliocene, or even perhaps Miocene. The rhyolite and rhyolitic tuffs of both districts are of Pliocene age.*

Page 45, line 12, *for* "grey trachyte," *read* "rhyolite."

Note ‡ on same page. The bufas, south of Guanajuato city, are formed of rhyolitic tuff.†

Page 48, line 3 *for* "an eruptive or prior date" *read* "an eruptive of prior date."

Page 48, line 17. According to Mr. Ordoñez‡ the succession of Tertiary eruptives in Mexico, commencing with the oldest, is as follows:—

Granites	—	Granulites.
Diorites	—	Diabases.
Andesites	—	Dacites.
Rhyolites.		
Dacites	—	Andesites.
Basalts	—	Basaltic andesites.

Mr. W. H. Weed, of the U.S. Geological Survey, who recently made a journey across the Sierra Madre from Parral to the Gulf of California, gives the order of succession of the rocks met with as follows:—(1) Andesite; (2) trachyte; (3) granite; (4) dacite; (5) rhyolite; and (6) basalt.§

In Zacatecas, there appear to be three systems of veins:—(1) North-west and south-east, dip southward, northerly dip exceptional, comprising most of the principal veins; (2) east and west, dip southward, northerly dip exceptional; and (3) north and south: this appears to be a minor system not well developed.

The Cantera and Quebradilla veins, and the Veta Grande, are examples of the first. The Cantera vein has already been described in the text. The Quebradilla vein (south of Zacatecas city) has an average strike of north 40 degrees west, and dips southward 55 degrees. The average thickness is 36 feet. This vein unites with the Cantera below the city.

The Veta Grande, 4 miles north of the city, has an average strike of north 52 degrees west, and dips southward from 55 to 60 degrees. It has been traced for 7 miles, but the principal workings are about 4 miles north of Zacatecas city, and extend for a length of a little over $2\frac{3}{4}$ miles. The thickness varies from 3 to 90 feet, but the average may be taken at about 30 feet. The following minerals have been found in the Veta Grande:—Native silver, argentite (*azul plomillosa* or the *polvorilla* variety), copper-pyrites (*bronce chino*), iron-pyrites (*bronce dorado*), pyrargyrite, cerargyrite (*plata azul* or *plata cornea*, AgCl), cerussite (*soroche plomoso*), and galena with or without silver (*soroche reluciente* and *tescatete* respectively).

The principal east and west vein is the important one known as the Veta de San Bernabé or Descubridora, 3 miles north of Zacatecas city. Malanoche, mentioned in the text, is on this vein. The dip is to the south. The silver contains 3 parts per 1,000 of gold. This vein contains iron-pyrites resembling

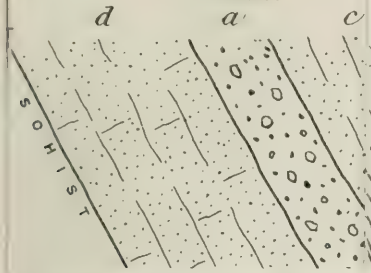
* "Las Rhyolitas de Mexico," by Mr. Ezequiel Ordoñez, *Boletin del Instituto Geológico de Mexico*, No. 14, pages 26-28.

† *Op. cit.*, Mr. Ordoñez, pages 21-26.

‡ *Boletín del Instituto Geológico de México*, No. 14, page 66.

§ "Notes of a Section across the Sierra Madre Occidental of Chihuahua and Sinaloa, Mexico," *Trans. Am. Inst. M.E.*, 1901, vol. xxxii., page 458.

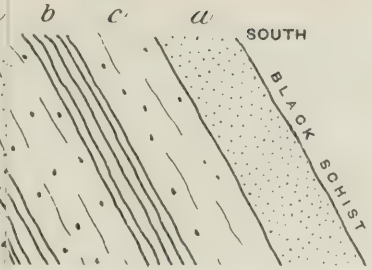
FIG. 3.



a, GALENA, IRON-PYRITES, BLENDE, SILVER-O ER-ORES, NATIVE GOLD AND SILVER, AND QUARTZ
b. NARROW STREAK OF ORE ON HANGING-WAL ATED IRON-PYRITES
c. MINERALIZED COUNTRY-ROCK ISTOSE COUNTRY-ROCK IMPREGNATED WITH QUARTZ,
d. MINERALIZED QUARTZ-ROCK MISPICKEL AND IRON-PYRITES

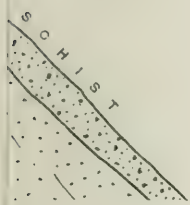
Scale, 8 Feet to 1 Inch.

FIG. 4.

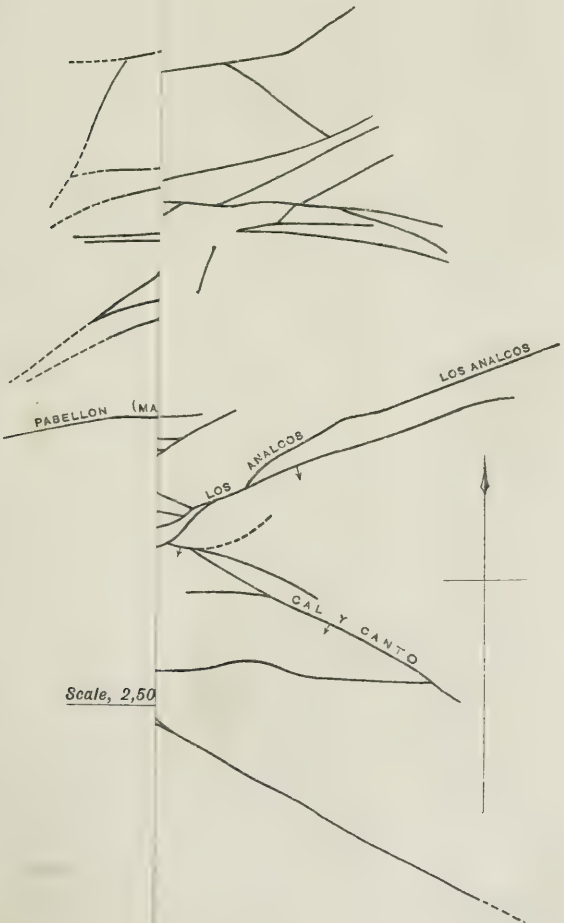


Scale, 8 Feet to 1 Inch.

H-EAST

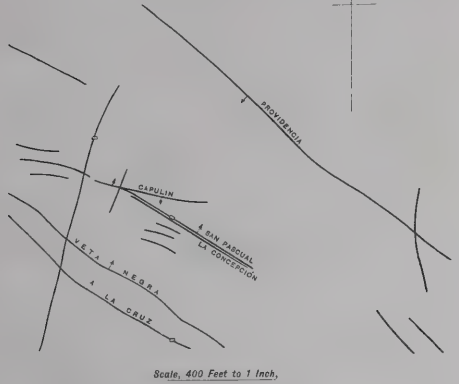


HIDES



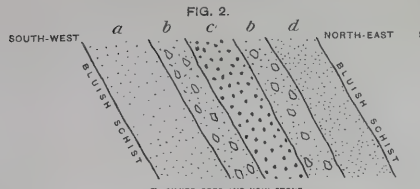
Scale, 2,50

FIG. 1.—PLAN OF THE MALACATE MINE.



Scale, 400 Feet to 1 Inch.

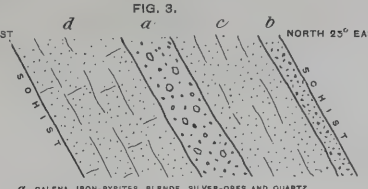
FIG. 2.



a, SILVER-ORES AND VEIN-STONE
b, GALENA AND VEIN-STONE
c, IRON-PYRITES AND VEIN-STONE
d, MISPICKEL, BLENDE AND VEIN-STONE

Scale, 8 Feet to 1 Inch.

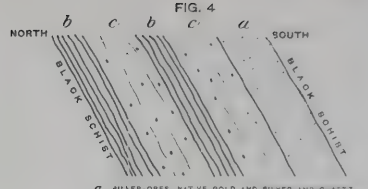
FIG. 3.



a, GALENA, IRON-PYRITES, BLENDE, SILVER-ORES AND QUARTZ
b, NARROW STREAK OF ORE ON HANGING-WALL
c, MINERALIZED COUNTRY-ROCK
d, MINERALIZED QUARTZ-ROCK

Scale, 8 Feet to 1 Inch.

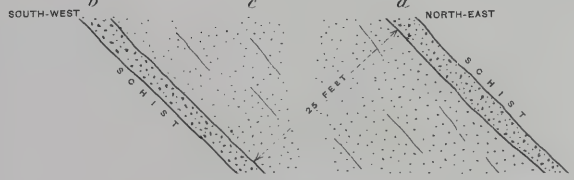
FIG. 4.



a, SILVER-ORES, NATIVE GOLD AND SILVER, AND QUARTZ
b, FOLIATED IRON-PYRITES
c, SCHISTOSE COUNTRY-ROCK IMPREGNATED WITH QUARTZ, MISPICKEL, AND IRON-PYRITES

Scale, 8 Feet to 1 Inch.

FIG. 5.



a, NATIVE SILVER, ARGENTITE AND QUARTZ
b, IRON-PYRITES, QUARTZ AND CALCITE
c, MINERALIZED COUNTRY-ROCK WITH 5 PER CENT. OF SULPHIDES

Scale, 8 Feet to 1 Inch.

FIG. 6.—PLAN.

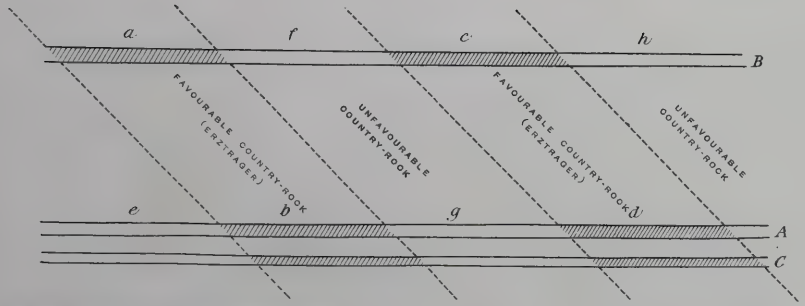
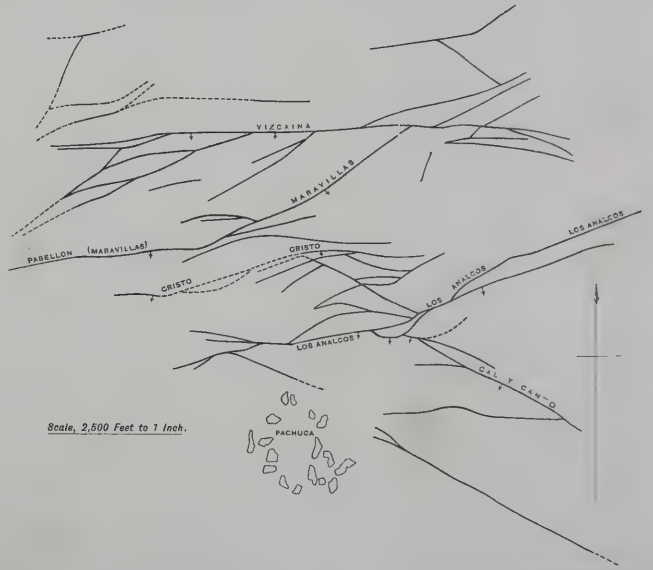


FIG. 7.—PLAN OF PACHUCA.



Scale, 2,500 Feet to 1 Inch.

Ann^d Reid & Comp^y L^td Newcastle upon Tyne

polished bronze in appearance, and called *bronce bruno*. It is highly argentiferous, containing up to 1,751 and 2,188 ounces of silver per short ton of 2,000 pounds. Ground in the *arrastres* it is known as *marmajas*.*

The silver-bearing veins of Zacatecas may contain, besides the ores mentioned in the text, stephanite (*acul acerado*), embolite (*plata verde* or chloro-bromide of silver), proustite (*rosicler claro*), polybasite and tetrahedrite or *fahlerz*.

The matrix is quartz, with some calcite, heavy spar, brown spar, and occasionally (as in the Cantera vein) fluorspar. Zinc-blende, magnetite, arsenical pyrites, malachite, azurite and stibnite (as, for instance, in the Quebradilla mine), are the heavy non-silver-bearing minerals.

Among the rare or accidental minerals found, nearly all of secondary origin, may be mentioned native sulphur, native bismuth (El Cristo and El Orito mines), bismutite (a hydrated carbonate of bismuth), cuprite (Cu_2O), bornite or variegated copper-pyrites ($3\,Cu_2S.Fe_2S_3$, from Refugio del Oro), bromyrite (AgBr from San Vicente and La Luz), iodyrite (AgI from Quebradilla), smithsonite (zinc carbonate from Albarradin), descloizite (vanadate of lead), and wulfenite (molybdate of lead).

The various deposits described in this series of papers occur in:—(1) recent eruptive rocks (Tertiary):—in Matapé (Sonora), in granite; in Taviches (Oaxaca), in hornblende-andesite; in Santiago Papasquiero and San Dimas (Durango), and in Zacatecas and Guanajuato, in andesites and rhyolites; in Pachuca (Hidalgo), in hypersthene-andesite; or (2) in sedimentary rocks with which recent eruptives are more or less closely related:—in limestone or schists of Cretaceous age in Santa Cruz de Alayá (Sinaloa), Tasco (Guerrero), and Sultepec (State of Mexico), and in schists of unknown age in Zacatecas and Guanajuato.

As already noted, at Taviches, Oaxaca, limestone has been found in one or two instances below the andesite. A belt of Jurassic limestone occurs 4 miles from the vein described near Matapé, Sonora; patches of Cretaceous limestone are found in the Zacatecas, Guanajuato and Sultepec regions, as well as in the vicinity of Pachuca, and the eruptive rocks of Durango probably cover Cretaceous limestone, as a belt of that rock runs in a general north-west to south-east direction immediately to the east of the eruptive masses. This general occurrence of a porous rock resembling limestone adjacent to, or not very far distant from, the silver-bearing veins described is noteworthy, and should be taken into account in considering the genesis of the deposits.

The PRESIDENT (Mr. W. O. Wood) moved that a vote of thanks be accorded to Mr. Halse for his interesting paper.

Mr. T. E. FORSTER seconded the resolution, which was cordially approved.

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* *Anales del Ministerio de Fomento*, vol. v., page 307.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING,
HELD IN THE WOOD MEMORIAL HALL, NEWCASTLE-UPON-TYNE,
JUNE 11TH, 1904.

MR. W. O. WOOD, PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on May 28th and that day, and of the Council of The Institution of Mining Engineers.

The SECRETARY read the balloting list for the election of officers for the year 1904-1905.

The following gentlemen were elected, having been previously nominated:—

MEMBERS—

MR. VICTOR BUYERS COLLINS, Mine-surveyor, Lewis Street, Islington, *via* Newcastle, New South Wales.

MR. RICHARD STANLEY DAVIES, Mining Engineer, Trynant Hall, Llanhilleth, Monmouthshire.

MR. JOSEPH EDWIN GOWLAND, Mining Engineer, Luchana Mining Company, Limited, Apartado 45, Bilbao, Spain.

MR. JOHN LAIRD, Engineer, Alliance Jute-mills, Shamnagur, Bengal, India.

MR. CLEMENT ALFRED RITSON PEARSON, Engineer, The Old Hall, Denby, near Derby.

MR. WILLIAM PIERCY, Engineer, 32, Grainger Street West, Newcastle-upon-Tyne.

MR. JAMES SHEPHERD, Mechanical Engineer, Hulne Avenue, Tynemouth.

MR. GEORGE ALFRED STONIER, Chief Inspector of Mines in India, 6, Dacre's Lane, Calcutta, India.

MR. JOHN RICHARD WILLIAMS, Metallurgist, P.O. Box 149, Johannesburg, Transvaal.

ASSOCIATE MEMBERS—

MR. WILLIAM COURTENAY DAWES CRUTTENDEN, 5, Laurence Pountney Lane, Cannon Street, London, E.C.

MR. ISHMAEL MINNOW, 4, King's Road, Camborne, Cornwall.

DISCUSSION OF MR. T. ADAMSON'S PAPER ON "WORKING A THICK COAL-SEAM IN BENGAL, INDIA."*

Mr. Thomas Adamson, referring to Mr. J. B. Atkinson's remarks on the scarcity of timber in India,† wrote that Mr. G. A. Stonier, chief inspector of mines in India, had stated that "in some cases, timbering is necessary, and it is as a rule in India well carried out. The rough village-carpenters become propping-mistries, and their work shows that they can be trained with considerable success. The timber used in mines varies from second-hand railway-sleepers to round timber; excellent examples of the use of the latter can be seen in the Assam and Burma collieries where timbering is heavy. One colliery‡ in Bengal has used 30,000 props in a year."§ These props cost 1s. 4d. (1 rupee) each, so that the cost is about £2,000 a year for timber.

Round timber or sal-wood *(Gavæus Gaurus)* grows freely in the jungles on and surrounding the Giridih coal-field. Timber, for use in the mines, is purchased close to the collieries, at a cost varying from 1s. to 1s. 4d. (12 annas to 1 rupee) per prop, measuring 7 to 8 inches in diameter and 22 feet in length. Second-hand railway-sleepers, used so extensively in the undergoing and in chocks, cost 1s. 4d. (1 rupee) each.

The statistics quoted by Mr. G. A. Stonier, chief inspector of mines in India, indicate that the method is relatively safe.

A "Memoir of the late William Cochrane," by Mr. C. A. Cochrane, was read as follows:—

* *Trans. Inst. M.E.*, 1903, vol. xxv., pages 10, 192 and 396; vol. xxvi., page 19; and vol. xxvii., pages 10 and 136.

† *Ibid.*, vol. xxvii., page 11.

‡ The East Indian Railway collieries at Giridih.

§ *Report of the Chief Inspector of Mines in India*, 1902, by Mr. Geo. A. Stonier, 1903, page 15.

MEMOIR OF THE LATE WILLIAM COCHRANE.

By CECIL A. COCHRANE.

William Cochrane was born on January 23rd, 1837, at Blackbrook, near Dudley, being the second son of Alexander Brodie Cochrane, later of The Heath, Stourbridge, and of Sedgley Hall, Staffordshire, Deputy-Lieutenant for the county of Stafford and proprietor of the Woodside iron-works.

After being educated at a private school at Wilmslow in Cheshire, he proceeded to King's College, London, where he had a distinguished career. In addition to natural ability he possessed the power of application in a marked degree, and numerous prizes for mathematics, French, German and Divinity fell to him during the years 1852, 1853 and 1854, culminating in his election to an Associateship of the College in the latter year.

From King's College, it was intended that he should proceed to Cambridge with a view to reading for the Mathematical Tripos and afterwards taking up the Bar as a profession, but the breakdown of his father's health compelled him to give up a University career, a necessity he frequently regretted in after-life. What this decision must have meant to him may be understood from a letter written after his death by a distinguished contemporary of his at King's College. In it occurs the following passage:—"It (the news of his death) carried me back to the days when he and I sat in the same classes at King's College, and when I envied him and Charles* their infinite (as it seemed to me) power of work and mental vigour. We expected him to do great things at Cambridge, and were disappointed when business claimed him. The two brothers were, I think, the strongest 'heads' we had at King's College."

From King's College, he went to his father's works and collieries in Staffordshire, and in 1857 came to the North of

* President of the Institution of Mechanical Engineers in 1889.

England to assist in the development of the coal-royalties in the possession of his father. After a brief residence in Darlington, he came to Newcastle-upon-Tyne in 1858 and was subsequently engaged in the sinking of Elswick colliery from the Low Main to the Brockwell seam, and the laying out and sinking of the Tursdale and New Brancepeth collieries. In addition to being connected at various periods of his lifetime with other mining properties (in South Wales and South Yorkshire), Mr. Cochrane was a director of, and consulting engineer to, the Blackwell Colliery Company, Limited, and the Nunnery Colliery Company, Limited, from their commencement.

At one time, he had an extensive practice as a consulting engineer, and his services were requisitioned in some very important mining cases and arbitrations.

It is perhaps, however, in connection with the mechanical ventilation of mines that his work as a member of the Institute will be best remembered. In conjunction with Mr. J. J. Atkinson, H.M. inspector of mines, and Mr. D. P. Morison, and later with Mr. Théophile Guibal, he conducted a prolonged and valuable series of experiments on ventilation, and embodied the results obtained in a number of papers read before the Institute. From the first a strong advocate of the use of centrifugal ventilators, he was instrumental in the introduction of the Guibal fan into this country in 1863, and on the death of Mr. Guibal in 1889 he read a brief notice of his life and work before the members of the Institute.

In 1875-1876, Mr. Cochrane co-operated with Prof. A. Freire-Marreco and Mr. D. P. Morison in investigating the conditions under which coal-dust would explode. A paper read in November, 1878, by Prof. Freire-Marreco, gave a complete account of the experiments carried out at the Elswick colliery and elsewhere.*

Mr. Cochrane was elected a member of the North of England Institute of Mining and Mechanical Engineers in 1859. In 1866, he was elected a member of Council, and in 1870 a Vice-President. He served the office of President in 1890 to 1891, and delivered a Presidential address in which he urged the importance of economy in the use of coal, having regard to

* "An Account of Some Recent Experiments on Coal-dust," *Trans. N.E. Inst.*, 1878, vol. xxviii., page 85.

the exhaustion of the thick seams and the increased difficulty and cost encountered in working thin seams at great depths.*

It is interesting to recall that Mr. Cochrane was Honorary secretary of the meeting of the Institute held at Manchester in 1865, and of the committee appointed to report upon the various Systems of Underground Haulage of Coal. He took a keen interest in a scheme of technical education started by the Institute in 1869, and was a member of the committee appointed by the Institution to carry it through. During the visit of the Institute to Douai in 1878 his mastery of the French language was of great service to the members. He took a very active part in the entertainment of the Belgian engineers who visited Newcastle in 1892, and acted as interpreter during their stay.

He acted as one of the representatives of the North of England Institute of Mining and Mechanical Engineers upon the Council and the Finance Committee of The Institution of Mining Engineers from its formation in 1889.

In 1868, he was elected a member of the Institution of Mechanical Engineers.† and he was also for several years a member of the Institution of Civil Engineers.

From its inception he took a keen interest in the Durham College of Science, of which he was a member of Council; and in 1901 the University of Durham conferred upon him the honorary degree of M.Sc. in recognition of his scientific attainments and labours on its behalf.

He took a prominent part in the promotion and management of the successful Exhibition held at Newcastle in 1887, and

* The papers communicated to the *Transactions* include :—

"Description of the Guibal Ventilator at Elswick Colliery," *Trans. N.E. Inst.*, vol. xiv., page 73.

"The Harrison Cast-iron Steam-boiler," *Trans. N.E. Inst.*, vol. xvi., page 35.

"A Comparison of the Guibal and Lemielle Systems of Mechanical Ventilators," *Trans. N.E. Inst.*, vol. xvi., page 57.

"Remarks on the Guibal and Lemielle Systems of Ventilation," *Trans. N.E. Inst.*, vol. xviii., page 139.

"The Advantages of Centrifugal-action Machines for the Ventilation of Mines," *Trans. N.E. Inst.*, vol. xxvi., page 161.

"Obituary Notice of the late Théophile Guibal," *Trans. Inst. M.E.*, vol. i., page 79.

"Presidential Address," *Trans. Inst. M.E.*, vol. ii., page 181.

"A Duplex Arrangement of Centrifugal Ventilating Machines," *Trans. Inst. M.E.*, vol. ii., page 483.

† "The Various Systems of Ventilation of Mines," *Proceedings of the Institution of Mechanical Engineers*, 1869, page 137.

devoted much time to the various committees of which he was a member.

No notice of Mr. Cochrane's life would be complete without a reference to the Sick Children's Hospital with which he was identified so closely. Himself one of the founders, he served the Hospital as honorary secretary for 25 years, and never ceased to work in its interest to the day of his death.

In 1898, he succeeded his brother Charles as chairman of Cochrane and Company, Limited, a position which he held at his death.

In 1859, he married Eliza, second daughter of William Blow Collis of Wollaston Hall, Stourbridge, who predeceased him. Mr. Cochrane died on November 25th, 1903, at his residence, Oakfield House, Gosforth, after a long illness, leaving two sons and one daughter.

Mr. A. L. Steavenson said that Mr. Cochrane joined the Institute a few years later than himself, and from that time until his death they were constantly in communication on matters which affected the interests of the Institute. On questions of ventilation, they took perhaps opposite sides for many years, Mr. Cochrane supporting the centrifugal fan, while he (Mr. Steavenson) thought, and still for some reasons thought, that the displacement-fan was the best: although, when they considered the large volumes of air which it was now necessary to deal with at some of the mines, he agreed that the use of the centrifugal fan was preferable. He felt great regret at now being present on the occasion of the reading of a memoir of their late friend.

Rev. Principal Gurney said that the Durham College of Science owed a great debt to this Institute, for it was founded jointly by the Institute and the University of Durham, and there was no member who took a more active interest in the development of the College than the late Mr. Cochrane. It must be satisfactory to the Institute, as founders of the College, to have observed the great strides which that college had made; and the measure of success which it had achieved was very largely due to the unsparing labours and the wise advice of Mr. Cochrane. On behalf of his colleagues, the staff and members of

the Council of the College, he deeply deplored his loss, which in some respects would be irreparable.

Mr. J. H. Merivale, in moving a vote of thanks to Mr. Cecil A. Cochrane, for his kindness in contributing a memoir of the late Mr. Cochrane, said that it would be incomplete without a reference to one of the strongest points in his character, namely, his great kindness of heart and liberality.

The President (Mr. W. O. Wood), in seconding the resolution, said that the members would heartily and sincerely endorse the remarks of previous speakers.

The resolution was approved.

THE LATE SIR CLEMENT LE NEVE FOSTER.

Prof. Henry Louis moved a vote of condolence with the widow and family of the late Sir Clement Le Neve Foster. Although that gentleman had retired from the position of H.M. inspector of mines, he was, at the time of his death, professor at the Royal School of Mines.

Mr. J. H. Merivale seconded the proposal, which was adopted.

The President (Mr. W. O. Wood) read the following paper on "The Re-tubbing of the Middle Pit, Murton Colliery, 1903":—

THE RE-TUBBING OF THE MIDDLE PIT, MURTON COLLIERY, 1903.

By W. O. WOOD.

Introduction.—The middle pit, Murton colliery, is one of the three historic shafts sunk at that colliery through the Magnesian Limestone and underlaying sand during the years 1838 to 1842. A paper on "Murton Winning in the County of Durham" was contributed by the late Mr. Edward Potter to the Institute.* It contains a very complete and interesting account of the operations, from the breaking of the ground on February 19th, 1838, until the three pits reached the Hutton Seam in April, 1843, five years later. A few leading facts of interest may be quoted, as follows:—

The depth to the bottom of the Magnesian Limestone is 456 feet. The thickness of the sand at the base of the Magnesian Limestone was found to be 34 feet 6 inches at the east pit, 27 feet 8 inches at the middle pit, and 26 feet at the west pit.

The engines employed were estimated to develop 1,584 horse-power, and were supplied with steam from 39 boilers. The engines drove 27 setts of pumps, of which 9 delivered to bank, and the total quantity of water raised when sinking through the sand was 9,306 gallons per minute from a depth of 540 feet.

From April 16th to May 10th, 1841, 17 buckets and clacks were changed per day, the cost of grathing the buckets being £2 5s. 10½d. each for the 19 inches setts, and £1 17s. 6d. each for the 16 inches setts. The consumption of coal, when all the engines were employed, amounted to 1,000 chaldrons (2,650 tons) per fortnight.

The pressure of the water at the base of the tubbing is upwards of 108 pounds per square inch.

* *Trans. N.E. Inst.*, 1856, vol. v., pages 43 to 61.

Many years ago, the west pit, used as an upcast, was entirely re-tubbed, and the east pit was re-tubbed in 1891.

Having regard to the age of the tubbing in the middle pit (1838), and to the fact that it was a little out of shape, although strengthened with internal strengthening-rings, it was decided to re-line this shaft also for a depth of 232 feet. The shaft is 13 feet 9 inches in diameter and is divided by a brattice into two drawing-shafts, the west side or polka pit drawing from the Main coal-seam, and the east side or middle pit drawing from the level of the Low Main coal-seam. The polka pit is a double-shift pit, drawing coals incessantly 20 hours per day; and the middle pit is a single-shift pit, drawing coals 10 hours per day, and occupied after coal-drawing hours in changing men, sending down material, etc.

The difficulty of re-lining this busy shaft, with four cages constantly ascending and descending, without stopping the pits appeared well-nigh insuperable. It was, however, accomplished without interfering with the coal-drawing in the least, or stopping either pit a single day; and a short description of the operation may be interesting, and prove of service to others similarly situated.

Figs. 1, 2 and 3 (Plate X.) indicate the general arrangements, showing the position of the engines, crabs, etc., employed, and the cradles, kibbles and ropes in the shaft.

Fig. 4 (Plate X.) shews the old tubbing, strengthening-rings, cages, timber, delivery-column, cables, pipes, and other obstacles. Fig. 5 (Plate X.) shews the shaft with the lining in position.

Figs. 6, etc. (Plate X.) shew the new tubbing, the bell-mouth, and special courses in detail.

A suitable bed for the new tubbing was selected at a depth of 96 feet below the lowermost wedging-crib.

Description of the Lining.—Very careful measurements were made at three points, and afterwards checked, of the shaft and fittings from the proposed position of the new wedging-cribs up to the point to which it was decided to carry the new tubbing, specially designed to suit the conditions. The metal used for the tubbing is of special quality and to specification.

The brackets are all internal. The height of each segment is 2 feet, and there are ten segments in each round or ring, except in special cases (Figs. 7 and 8, Plate X.).

Method of forming the Rings of Tubbing.—The joints are machine-planed so as to make a perfect vertical joint, and then bolted firmly together into a complete ring. The ring, thus formed, is then placed on the face-plate of a special lathe, large enough to take in the ring, and both of the horizontal flanges are properly faced to gauge. Part of the tubbing was dealt with by machinery in operation for making the metal-lining of some of the London tube-railways and with the same accuracy.

The vertical and horizontal joints have three V-shaped grooves on each face, and are made metal to metal (as it was not considered advisable to use any of the usual jointing-material). There are 40 bolts, 1 inch in diameter, in the entire circle, and 4 bolts are used in each of the vertical joints.

Each ring is cast with bracketted grooves (Figs. 9 and 10, Plate X.) to receive the brattice, which divides the pit into two portions, and every third ring is cast with pockets (Figs. 11, 12 and 13, Plate X.) to receive the guide-buntons and stringing-planks. The individual segments were numbered round the ring, and each completed ring was marked from the lowermost crib upward, so as to come into its proper place: no alterations of the bolt-holes, etc., being required in fitting them together in the shaft.

The largest inside diameter of the old tubbing is 13 feet 9 inches, and that of the new tubbing is 12 feet 6 inches throughout. The space between the two tubbings is about 4 inches, and it is filled with a cement-concrete composed of 3 parts of shingle, sifted over a $\frac{1}{4}$ inch screen, and 1 part of best Portland cement. The cement-concrete was rammed solid, as each ring of tubbing was placed in position, each course of cement-concrete being left about 1 foot below the upper edge of each ring of tubbing; and if there should be any chance of a parting in the cement-concrete (which is hardly probable) it will not occur directly opposite an horizontal joint in the tubbing.

The lower courses of the tubbing were, of course, large enough to suit the crib-bed, A and B, made to receive it after

the brick-walling had been taken out. It consists of one bottom-crib, A, 13 feet 9 inches in inside diameter and 1 foot 5½ inches broad on the bed (Figs. 14, 15 and 16, Plate X.). This was wedged in the usual way, and a second crib, B (Figs. 14, 17 and 18, Plate X.), 1 foot 8½ inches broad on the bed was laid upon it and wedged. The upper crib, B, is made with a snug or lip, *a*, all round it, to which the first or foundation-course, C, of tubbing (Figs. 14, 19, 20 and 21, Plate X.) is bolted, both surfaces being machine-planed.

The foundation-course of the tubbing is narrowed in diameter and each of the four bell-courses, D, E, F and G (Fig. 14, Plate X.), are inclined at the same angle.

The top course reduces the inside diameter to 12 feet 6 inches —the finished size of the rest of the new tubbing. The whole of this portion of tubbing is backed with cement-concrete.

There are two special courses of tubbing, the necessity for the first one, H (Figs. 6 and 22, Plate X.) arising at the top of the forty-fifth course of tubbing. It is a combined wedging-crib and water-ring, placed opposite to a crib in the old tubbing.

The second special course, I, was necessarily used (Figs. 6, 23 and 24, Plate X.) to pass a wedging-crib, which has a strengthening-ring placed in front of it. It was not deemed advisable to remove this ring, and a special course of tubbing was designed to pass the obstruction. The body of this course extends to, and in a line with, the flanges of the tubbing; and the flanges of the course are only used at such positions in the shaft as to be quite clear of the passing cages.

Immediately above this course, I, is placed one course of the plain tubbing, and, behind it, is fixed a ring, K, of wrought-iron pipes, 2 inches in diameter, with a number of ⅜ inch holes drilled in it; no cement is placed between the ring, K, and the plug-holes in the tubbing (Figs. 23 and 24, Plate X.). This ring was placed at the top of the eighty-third course of tubbing, for the purpose of removing any water that might find its way through the old tubbing above, and was protected above (and below) with a layer of wood and connected to water-ring pipes, M, 3 inches in diameter.

The total number of 2 feet courses of plain tubbing used is 114, together with 2 special courses, and the work, including

the shifting of the rising main, occupied 723 hours, as follows:—Taking-out walling and making ready the lowermost crib-bed, 96 hours; laying and wedging the two main cribs, 80 hours; putting in the remainder of the bell-tubbing, 32 hours; replacing the kep-buntons and shifting the rising main, 64 hours; putting on the straight courses of tubbing, and including the special courses, 259 hours; and taking out the cage-timber, getting the cradles, etc., and replacing the same in time for coal-work, 192 hours.

The work was accomplished without the slightest accident of any kind: being commenced on Good Friday, April 10th, and finished on November 7th, 1903. These dates include 6 week-ends, when operations were entirely suspended from various causes.

Method of Working while the Tubbing was being put in.—The four coal-cages were left in the bottom of the pit, and the down ropes were lashed to the side of the pit (Figs. 1, 2 and 3, Plate X.).

Two cradles were made to suit each side of the pit, the polka-pit-side cradle being attached to the horse-crab, N (Fig. 2, Plate X.), and the middle-pit-side cradle to the crab-engine, O. The west-pit jack-engine, P, "waited on" with a kibble at the polka pit; and the east-pit jack-engine, Q, performed the same duty for the middle pit.

None of the dividing brattice was removed during the operations. The ends were cut to suit the brackets designed for its support in the new tubbing.

Four men worked on each cradle in each shaft.

The cement-concrete was properly gauged and mixed at bank, previous to being sent down the pit.

The preparations for getting the pit ready, placing the ropes over the pulleys, hanging the cradles, refixing the cage-timbers, lifting out the cradles, and hanging the cages for coal-work, occupied 8 hours for each spell of work at the new tubbing.

APPENDIX.—Journal of Operations in Relining the Tubbing of the Polka and Middle Pits, Murton Colliery, in 1903.

			Hours.	Hours.
April	10.	Took out walling and prepared the crib-bed ...	72	
,,	18.	Do. do. do. ...	24	
			—	96

APPENDIX.—*Continued.*

			Hours.	Hours
May	25.	Laid and wedged the lowermost crib	24	
,,	9.	Laid and wedged the second crib, and put on the first and second courses of tubbing ...	32	
,,	16.	Put in concrete backing	24	
,,	23.	Put on 4 courses and finished the bell-tubbing	32	112
,,	30.	Put on 2 courses of straight tubbing, and replaced the kep-buntons of the rising main with steel-girders		72
June	6.	No work done.		
,,	13.	Finished the kep-buntons, and shifted the rising main		24
,,	20.	Put on 7 courses of tubbing		32
,,	27.	Put on 6 courses of tubbing		24
July	4.	Put on 7 courses of tubbing		23
,,	11.	Put on 9 courses of tubbing		24
,,	18.	Put on 9 courses of tubbing, and cut out the strengthening ring in front of an old wedging-crib ...		22
,,	25.	Took out an old water-ring, below the old wedging-crib, and put in a new one below the new crib, carrying the 3 inches pipes up to it. Put on 2 courses of ordinary tubbing, and one course, 1 foot 10 inches high, and finished level with the bottom of the old wedging-crib, making 48 courses to this point		24
August	1.	Put in additional collarings to the rising main, also a new wedging-crib and water-ring combined, H, in front of an old crib, wedged it, and put on 10 courses of tubbing		48
,,	8.	Put on 4 courses of tubbing		16
,,	15.	Put on 7 courses of tubbing		24
,,	27.	No work done.		
,,	29.	Put on 6 courses of tubbing		24
Septr.	5.	No work done.		
,,	12.	All the water was wedged off at the sand-crib. Put on 6 courses and one special course of tubbing, I, to pass the wedging-crib and rings without lessening the diameter of the shaft. Put on one course above the special course, making 83 courses in all to this point		32
,,	19.	A circle of wrought-iron pipes, 2 inches in diameter, with $\frac{3}{8}$ inch holes, was put in between the new and old tubbing, and the cement-concrete was left out below this ring and the plug-holes of the new tubbing immediately below. Above this circular piping, wooden sheeting was put in, and above the sheeting the space was filled to the top of the last segment put on the previous week-end with stiff cement-concrete. Part of the plugs of the last course of new tubbing were left out, and a quarter water-ring was put in below these holes on the south side of the shaft. The water-pipes, 3 inches in diameter, were then connected to this ring		30

FIG. 15.—ELEVATION.

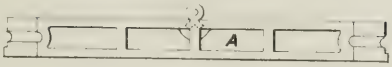


FIG. 16.—PLAN.

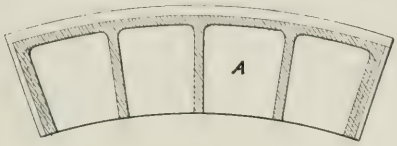


FIG. 17.—ELEVATION.

FIG. 18.—PLAN.

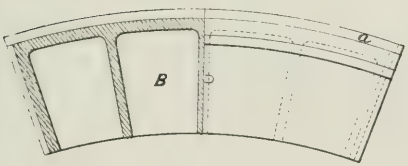


Fig 1 Section

Fig 2 - Plan

Scale, 40 Feet to 1 Inch.

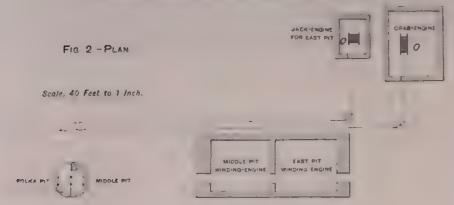
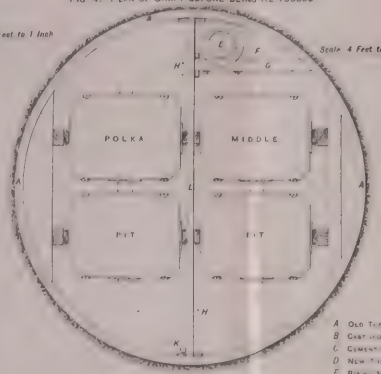


Fig 3 - Plan

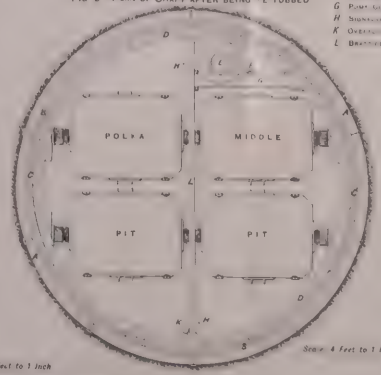
Scale, 40 Feet to 1 Inch

Fig 4. Plan of Shaft before being Re tubbed



Scale, 4 Feet to 1 Inch

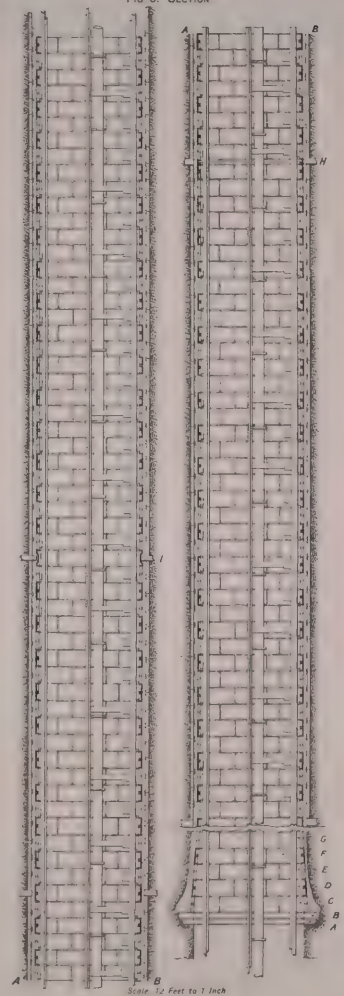
Fig 5 Plan of Shaft after being Re tubbed



Scale, 4 Feet to 1 Inch

A Old Tubbing
B Cast iron Ring
C Cement Concrete
D New Tubbing
E Rising Main of Pipes
F Ele. Tr. Cables
G Pump Discharge
H Signal Wires
K Overflow Pipe
L Brattice

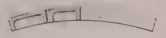
Fig 6. - Section



Scale, 12 Feet to 1 Inch

Fig 7. - Elevation

Fig 8. - Plan



Scale, 2 Feet to 1 Inch.

Fig 9. Elevation

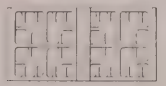


Fig 10. - Plan.

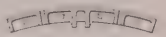


Fig 11 - Elevation.

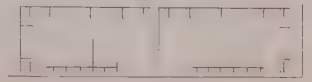
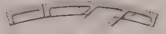


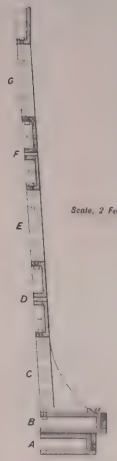
Fig 12. Plan

Fig 13 Plan



Scale, 2 Feet to 1 Inch

Fig 14 - Section



Scale, 2 Feet to 1 Inch.

Fig 15 Elevation

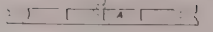


Fig 16. Plan

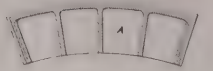


Fig 17 Elevation

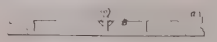


Fig 18. Plan

Scale, 2 Feet to 1 Inch.

Fig 19. - Elevation

Fig 20. Cross section

Fig 21 Plan

Scale, 2 Feet to 1 Inch

Fig 22 Section

Fig 23. Section

Fig 24 - Section

Scale, 2 Feet to 1 Inch

APPENDIX.—*Continued.*

			Hours.
Septr.	26.	Put on 12 courses of tubbing. The strengthening-rings on the old tubbing terminated at the tenth course or ninety-third course from the bottom, making 95 courses in all	32
October	3.	Put on 8 courses of tubbing	28
,,	10.	Put on 4 courses of tubbing	13
,,	17.	No work done.	
,,	24.	No work done.	
,,	31.	No work done.	
Nov.	7.	Put on 7 courses of tubbing, topping the last with 3 courses of brick-and-cement to protect it, making 114 courses in all	23
		Total time	723

NOTE.—From the bottom of the lowest wedging-crib, it is 13 feet 7 inches to the top of another crib. From the bottom of this crib, it is 53 feet 10 inches to the bottom of the crib, I, at the top of the sand, where most of the water is coming out from the closing course below it. All the old tubbing, level with the ninety-third course of new tubbing, had strengthening-rings placed in front of it and wooden filleting placed between these rings. This filleting was taken out before the cement-concrete was put in.

The PRESIDENT (Mr. W. O. Wood) said that he was very much indebted to the resident manager of the colliery (Mr. S. Hare) and to the engineer (Mr. R. H. Oughton) for the way in which the work had been carried out. It was a long and arduous piece of work, to which it was necessary to devote Sunday after Sunday for several months. It had to be done very carefully, as the members might judge from the precision with which the tubbing was manufactured.

Mr. T. E. FORSTER said that papers of this kind, although they might not evoke much discussion, were of great value and assistance to others. He had pleasure in proposing a vote of thanks to the President for his paper.

Mr. C. C. LEACH, in seconding the resolution, asked why the tubbing was bolted together, instead of being wedged in the ordinary way.

Mr. T. E. FORSTER said that he had tried tubbing with inside flanges and using ordinary sheeting, but it was a most difficult matter to make it watertight.

Mr. A. L. Steavenson remarked that the paper was a record of the successful completion of one of the most difficult mining operations with which he had met, and it was noteworthy that it had been carried out without loss of life.

Mr. W. C. Blackett asked whether the old tubbing leaked; whether the new tubbing was subject to hydraulic pressure in consequence; and whether, in contemplating the removal of the pressure from the old to the new tubbing, consideration had been given to the possibility of any motion of the old tubbing.

The President (Mr. W. O. Wood) said that there were several reasons for the adoption of the method of tubbing described in the paper, but the principal of these was that he had previously tried the usual method of wedging the tubbing in the east pit shaft; and, if there had not been what might be described as a "Providential strike" at the time, they would never have accomplished the work, within a reasonable time. The work was done at week-ends and holidays; it took 8 hours to prepare the pit, and on ordinary days there was only an interval of 4 hours between the cessation and resumption of coal-drawing, as the pit drew coals for 20 out of 24 hours, so no work could be done during the week. There were a few leaks, amounting to about 40 gallons per minute, but he did not consider it advisable that they should be closed. One of the special segments of the new tubbing was provided to take away the water from one of the largest leaks in the old tubbing. The tubbing was subject to hydraulic pressure, just the same as the old, and he expected, by this time, that the new tubbing and the cement-concrete behind it was taking all the pressure; if there had been any opportunity for an accumulation of air behind the old tubbing, it might cause some movement, but the new tubbing strengthened it, and with the excellent cement-concrete lining, the water could have no effect on the new tubbing.

The vote of thanks was cordially approved.

The Secretary stated that Mr. Clarence R. Claghorn's prize had been awarded to Mr. H. W. G. Halbaum for the following essay on "The Action, Influence and Control of the Roof in Longwall Workings":

THE ACTION, INFLUENCE AND CONTROL OF THE ROOF IN LONGWALL WORKINGS.

By H. W. G. HALBAUM.

The order of division adopted in this paper is that indicated by the above title. The observations herein contained are suggested partly by personal experience of longwall workings, and partly by mechanical and geological theory. Scientific terms, such as pressure, action, etc., are, for the most part, used in the same wide sense as that employed by practical men in common conversation. And the aim of the paper is to indicate broad principles, rather than to discuss the particular manner of their application to local cases.

I.—The Action of the Roof.

Every roof is subject to the law of gravitation, in virtue of which it is endowed with weight, pressure, and, in the actual longwall working, with motion, momentum and kinetic energy. Every roof is also subject to fracture, decay and disintegration. Every roof is, moreover, endowed with a certain amount of elasticity, either real or practical, for the miner will tell you that the roof bends before it breaks, while the geologist need only point to the anticlines, synclines and contorted strata of the earth's crust in order to prove that, from the practical standpoint at least, the rocks possess the ability to yield to pressure by bending.

(1) *The Pressure of the Roof.*—The case of the unworked strata is simple. Here we have a statical pressure, a pressure at rest. There is a vertical line of pressure evidently due to gravity. But there is also a horizontal line of pressure due to the lateral compression of the rocks. This also is primarily due to gravity, since all the rock-particles press to the centre of gravity: for it must be remembered that the various lines of gravity are not parallel but radial, and the convergence of

all the rock-masses to a common centre must necessarily set up a lateral compression. The end-thrust thus created probably sustains part of the vertical weight, and general experience of working coal-mines shows that it is only after you have got the first big fall in the goaf, and so relieved the lateral compression, that you get the "weight" on the coal below to the fullest extent.

(*a*) *The Draw.*—The mine-working being got under way, and the lateral compression of the rocks being relieved by the first big fall in the goaf, it is reasonable to suppose that for some distance beyond the coal-face, and above the solid coal, the original lateral thrust of the overlying strata will find effect in a lateral movement of such strata towards the face outward. This movement in turn will develop incipient lines of fracture above the solid coal, the roof begins to crush the coal by its sheer weight, and the resistance of the artificial packs being less than that of the solid coal, the strata begin to bend down over the coal-face on to the packs behind. The effect of this disturbance is observed belowground in the crushing of the coal, and is often visible at the surface at a point many feet in advance of the working face. This point lies on the shore-line of the subsidence at the surface caused by the working below, and the distance by which this point leads the line of the working-face is technically known among mining surveyors as the "draw." The draw, it will be understood, always lies beyond the face-line, while the goaf and the subsidence proper lie behind the face-line (Fig. 1, Plate XI., and List of Illustrations).

(*b*) *Oblique Direction of the Total Pressure.*—It appears, therefore, that the action of the roof is not quite so simple as might at first be supposed. We have, first, a force due to the sheer weight of the strata, acting along the line of gravity. We have, in the second place, a force due to the end-thrust of the strata as their natural lateral compression is relieved by successive falls into the excavation. Wherefore, in the third place, we have the oblique resultant of these two component forces. In cases of subsidences due to purely natural causes acting in former geological ages, the oblique resultant has had

time to define its direction clearly, as seen in the hade-lines of various faults. In the case of a mine, however, the area of the subsidence is continually being enlarged; the fault-line is continually shifted forward as the working-face advances, and the incipient hade existing for the time being cannot be so clearly traced and defined. But it seems reasonable to infer that this incipient hade-line, and therefore, the resultant of the component forces which produce it, lie approximately along the hypothenuse of a right-angled triangle whose two sides are roughly equal to the depth of the seam and the length of the draw respectively. For every force produces its effects in the line of its own action.

(*c*) *Nature of the Pressure.*—In many cases, and for varying intervals of time, the pressure may remain practically statical. But "weightings" of the roof, and the gradual descent of the roof, are matters of common knowledge. Hence, the pressure, so called, may often be in reality the power due to kinetic energy and accumulated work. And from the practical standpoint, the pressures, so far as the most violent effects are concerned, may certainly be described as intermittent in their action.

II.—The Influence of the Roof.

The Influence on the Coal.—This sub-head is taken first in order, only because it is the first that would occur to a practical miner. The effects of the roof-action on the coal are to crush it more or less, and render it easier to be gotten by the miner. The general principle of longwall working from this particular point of view may be briefly explained.

The bord-and-pillar system and the longwall mode have this principal point of difference. In the bord-and-pillar system, the goaf being allowed to fall freely, the coal at the goaf-edge sustains the normal pressure due to the weight and the draw. The longwall system brings a greater pressure to bear upon the coal. The roof is not allowed to break off bodily at the face-line, but is projected therefrom like a cantilever over the face of work and on to the sinking heads of the packs behind. In the bord-and-pillar system the action of the roof is more nearly allied to that of a simple weight; in longwall, it is more nearly allied to the action of a powerful lever. We may exert a power

sufficient to bend this lever, and do well. Or we may guide the power in such a manner that the lever snaps on its fulcrum and becomes useless. Referring to Fig. 2 (Plate XI.), if the length of the lever be AD, it will be seen that if it snaps (in the practical sense) at B, the advance of the face will soon make the relative position of the fracture occupy the site C, and the crushing effect of the lever on the coal will be reduced to zero. The great object of longwall, therefore, is to secure the continuous transmission of pressure to the coal-head, not only from the roof above the coal itself, but also from the roof superposed above the face of work and the packs behind.

The intensity of the effects produced by this leverage on the coal will be modified by the nature of both the roof and the floor. If both be very soft, the intensity of the effects will be less. If both be very hard and strong, the effects on the coal may be so violent as to crush it unduly and reduce its market-value. This phase of the matter will be further considered at a later stage.

The Reaction on the Roof itself.—The influence of the roof-action recoils in some measure on the roof itself. The nature of the pressure, especially that portion of it more particularly due to the draw has already been alluded to. The action on the coal is distinctly intermittent, sometimes it is merely a statical pressure, at other times the action is more truly defined as kinetic power. The effects of this intermittent pressure or power are those of a hammer at work, the roof corresponding to the hammer, and the coal, etc., corresponding to the anvil. The effects on the anvil have been referred to in the previous section.

Theory of the Reaction.—But according to a wellknown physical law, acti n and reaction are equal and opposite. Hence, the action of the hammer on the anvil is equal to the reaction of the anvil on the hammer. The preservation of the roof in longwall is a matter of importance, and it is by no means an academical nicety to state the following practical proposition:—In any longwall working, if the action of the roof be small, the reaction on the roof itself will also be small; and conversely, if the action be large, the reaction will also be large. In applying this principle to the deterioration of a roof, however, it is

necessary to remember that the deterioration of the roof will depend not on the total reaction, but upon the reaction per unit of mass. For example, if the roof be very thick, you may have a very large total action, and an equally large total reaction; yet the deterioration may be comparatively small, simply because, although the total reaction be large, the reaction per unit of mass is small.

But, according to the same theorem, action and reaction are not only equal in amount, but also opposite in direction. The oblique direction of the total action has already been shown. The line of the reaction, therefore, is simply the line of action with contrary motion. Hence the action of the roof, the reaction upon the roof, and the fractures produced in the roof by such reaction, all lie in the same straight line. Therefore, the great lines of fracture in the longwall roof are deflected from the true vertical line, and lean in the direction of the limit of the draw.

The foregoing seems to disclose an interesting and important principle of practical value. It clearly proceeds *a priori* from physical theory; it is proved *a posteriori* by geological phenomena and by longwall experience, and it explains mining phenomena which would otherwise be inexplicable. The obliquity of the line of fracture accounts for many things which could not be reconciled with any theory of vertical fractures.

Associated Phenomena of the Reaction.—Assume, as an example, that in a given case, the angle of the obliquity is 10 degrees. Then, referring to Fig. 3 (Plate XI.), the depth of the mine and the length of the draw are in the same ratio as the lines AB and AC; and the angle of the obliquity is CBA. The direction of the roof-action is CB; that of the reaction is BC, and the lines of fracture lie in, or parallel with, the same line.

Transmission of Pressure.—As the working-face advances, successive lines of fracture are produced as shown in Fig. 4 (Plate XI.). Taking any pair of them, it is seen that the section of roof between them reposes on the section beyond at an angle of 10 degrees. Thus, *e* reclines on *d*, *d* on *c*, *c* on *b*, *b* on *a* and *a* finally reclines on the solid roof at A. Hence, pressure is transmitted from *e* through *d*, *c*, and *b* to *a*, and thence to the solid roof at A and the coal below. It is evident that this trans-

mission of pressure could not take place if the fractures were vertical, or if they were deflected to the opposite side of the vertical line.

"Weightings" of the Roof.—Also, each section, *a*, *b*, etc., must, by the nature of the case, slip down from its hanging-wall before it slips on its foot-wall. Thus, in the circumstances portrayed by Fig. 4 (Plate XI.), section *a* will presently slip down on its hanging side as *b* did before it. But the hanging-wall of *a* is the foot-wall of *b*, and a similar relation obtains between each pair of adjacent sections. Hence when *a* slips from its hanging-wall, the foot-wall of *b* slips also. The slip of *b* in turn depresses the foot-wall of *c*, and so on throughout the entire series. Thus the slip of *a* is followed by the bodily slip of the whole roof over the face of work and the packs just behind, the result being known as a "weighting."

The Bending of the Roof.—Again. When the section *a* slips on its hanging side, the bodily motion of *b* follows, and so on to *e* and *f*. It is evident that the leverage of each section varies directly as its distance from A. The movement commencing at *a* continually gathers momentum as it proceeds. The fall of *b* must exceed that of *a*; the fall of *c* exceeds that of *b*, and so on. If we plotted to scale these different falls of the various sections, we should require to take these accelerations into account, and their magnitudes vary as the distances from A.

But the motion described is arrested, and the manner of this arrestment must also be considered. When section *a* slips on its hanging side, it is clear that section *b* would immediately slide right down to the floor if nothing occurred to prevent it. Now what prevents it from doing so? Only the fact that the combined weights of all the sections from *c* onward immediately force *b* against its foot-wall, and hold it there by lateral thrust. It is literally caught by a pair of self-acting clamps. Similarly, section *c* is arrested in turn by the lateral thrust due to the combined weights of all the sections from *d* onward, and so on throughout the series. Here, then, we have a thrust which comes into play at each successive motion originated at A, a thrust which arrests the motion of each section in turn, and a thrust the grip of which on each section varies inversely as the distance from A.

Then, since the moment varies as the distance from A, and since the power of arrestment varies as the reciprocal of this distance, it follows that during any given weighting, the travels of the various sections must vary as the squares of the distances from A. Plotting the various travels on these lines, the bases of the several sections arrange themselves in the newly-depressed roof-line along a parabolic curve the vertex of which is at A. Thus, the effect of all the various accelerations taken together is the bending, so-called, of the longwall roof. This result, much exaggerated of course, is shown in Fig. 5 (Plate XI.). The positive amounts of travel accomplished by the various sections in the ordinary practical case are too small to be appreciated by the senses, or we might not perhaps, in our mining idiom, have come to speak of them, or of their effects, in the way that we do.

The "Locking" of the Roof.—The miner often speaks of the roof "locking" itself. One may go into a longwall face of work and find all the timbers, or most of them, broken, or split, or sunk for inches into their soles and caps. And yet it often happens that if the whole of the timber, sound and otherwise, be removed, the entire roof remains in position. Why? The answer is obvious. The great roof-sections, by successive slips, have descended a few inches; the precipitation of the enormous weight on to the timber has smashed it to splinters, it may be; but the motion has been arrested for the time being by the lateral thrust above described, and the great body of strata remains securely gripped in the powerful jaws of its natural clamps. It appears, then, that a simple application of physical theory (the third law of motion, in fact,) easily and naturally explains many notable longwall phenomena.

The Mechanical Disintegration of the Roof-stratum.—By the roof-stratum is meant that stratum (or, it may be, those strata) lying immediately above the coal-head. From one point of view, the roof-stratum is a bridge that extends across the face of work. When the roof "bends," the strain is greatest at the roof-line, because the radius of curvature is least at the roof-line. In a previous section it was seen that this "bridge" withstands immense "weightings" and exhibits apparent "bendings" simply because the arrangement of its constituent

parts is such that the sudden "weighting" of the bridge has the effect of automatically putting it into compression from end to end, so that the bending of the bridge under its load becomes also a bending which accentuates the curvature of the arch. In short, the stresses on the roof-stratum are variable in amount, variable in kind, and intermittent in their application. Such a combination of stresses, and such a manner of their application cannot but exert a most destructive effect on the roof-line. The mechanical disintegration of the roof-stratum is, therefore, much more rapid than that of the superposed strata. Hence, while the upper strata remain practically locked in position, the roof-stratum is liable to be broken into fragments.

Efficiency of the Timber. It is the office of the timber to prevent the fragments of the roof-stratum from falling out and causing injury to the workers. The timber can never support the weight above the bridge at the roof-line: it is merely a system of centres, so to speak, the object of which is to maintain the constituent parts of the bridge in their relative positions. The timber no more sustains the weight of the body of roof than the copper-pins in the self-detaching hook sustain the weight of the loaded cage. The sole object of the timbering and its perfect efficiency are secured if the fragments of the shattered roof-stratum are maintained in their relative positions.

Mysterious Accidents from Falls of the Roof-stratum.—It seems very probable that the theory of intermittent stresses, compressive and tensional, set up in the roof-line especially, accounts very easily for at least some of those mysterious accidents which arise from the sudden fall of more or less massive fragments from the roof-stratum. Observe that in the great majority of instances, the victim is injured or killed by a falling fragment of the roof-stratum only, and not by a large fall from the great roof-body. A large proportion of these accidents appear mysterious by reason of two notorious facts: Firstly, they occur under an apparently good roof: and, secondly, they occur soon after a satisfactory examination of the roof. If we assume that the examination took place in the interval between the action of two stresses of opposite kinds, the mystery

of the accident vanishes at once. It merely emphasizes the old lesson that we should trust no roof whatever, but timber all of them with the utmost promptitude.

The Influence of the Roof upon the Roads.—The effects produced on the roads are so wellknown that they require little treatment here. The pressure is often sufficient to cause the gobbing to act as a semi-fluid, transmitting much lateral force against its binding walls and thrusting them into the road. If the floor be moderately soft, pressure is again transmitted laterally from underneath the packs to the road-floor. These two lateral pressures, one from the foundation of each pack, meet in the middle of the floor, and finding their least line of resistance upward, burst the floor-stratum, which is said to "heave" or "creep," as it rises into the road-area. Such results are illustrated in Fig. 6 (Plate XI.), where ABCD is the original cross-section of an imaginary road, and EFGH the cross-section of the same road as subsequently reduced by the pressure. Other things being equal, such effects are more marked in the deeper mines, on the softer floors, and in the thicker seams.

III.—The Control of the Roof in Longwall Workings.

The term, control of the roof, is herein construed with a good deal of elasticity. By the successful control of the roof is meant the obtaining of good results, whether they be obtained by aid of the roof-action, or in spite of it, or by simply running away from it. Such a definition of control may not be in strict harmony with the letter of etymology, but it harmonizes perfectly with the practical spirit of this paper.

Control by Direction of Working.—The direction of working is often defined with reference to the cardinal points. In this paper, however, it must be defined with reference only to two lines "graven in the rocks" by geological forces. One of these is the line of dip; the other is the line of cleavage. The angle at which these lines intersect each other varies in different localities. Hence in one locality the angle made by the direction of working with one line may accentuate the effects produced by the angle made with other line; whilst in another locality the angle made with one line may to some extent

counteract the effects due to the other angle referred to. It is therefore necessary to consider the angle with dip and the angle with cleavage in quite separate sections.

(*a*) *The Angle with the Line of Dip.*—Whether the working advance to the dip or to the rise, the force due to the sheer weight of the overlying strata will act in the vertical line. But the useful effect of the lateral thrust will be different. For, in working to the dip, the lateral thrust of the strata beyond the face-line is resisted by all the weight of the strata behind; whilst in working to the rise the lateral thrust of the strata beyond the face-line is not merely unresisted, but is, in a very positive sense, facilitated by the weight, which naturally tends to slide downhill, and thus accentuate the draw at the surface and exert a mangling action on the coal-head such as cannot be obtained in working to the dip. On the other hand, the roof is more liable to break off at the face-line in rise-workings, unless the packs be kept well up to the face.

As for the influence of dip on the maintenance of the roads, it may be remarked that roads along the line of strike are more difficult to maintain than roads in the line of dip. For, owing to the direction of the roof-action, the liability of the packwalls to lateral displacement is greater when the road is in the line of the strike, and such walls should therefore be tied with substantial cross-walls at frequent intervals.

Working to the rise also involves a larger expenditure of timber than does working to the dip. For, whatever tends to break off the roof at the face-line equally tends to throw the weight on the timber and packs behind. And it is hardly necessary to add that whatever impairs or reduces the efficiency of the timbering must coincidently affect the standard of safety. Hence, several pros and cons are to be considered before one can, in any particular case, decide on the definite angle that the direction of working should make with the line of dip.

(*b*) *The Angle with the Line of Cleavage.*—The important effect of this angle is too well understood to need much description here. But it is necessary to consider this angle from the standpoint of the roof as well as from that of the coal. It may firstly be enunciated, as a cardinal principle, that the planes

of cleavage, incipient or pronounced, existing in the overlying roof-strata, strike in the same general direction as the planes of cleavage existing in the coal below. The importance of this principle, and the necessity of its acceptance, justify a reference, by way of proof, to the natural philosophy of the case. According to geological theory, the cleavage in the coal and in the roof-strata was produced by the action of the same force. Assuming that in a given case, the planes of cleavage are vertical, the theory is that some force, acting laterally, and at right angles to what are now planes of cleavage, was the cause of such cleavage being created in the strata. Such a lateral force is supplied by the shrinkage of the earth's crust, this in turn being due to the cooling of the planet through vast ages of time. This force, acting with immense energy on the particles of matter in the strata, and subjecting them to enormous lateral compression, obliged such particles so to rearrange themselves that their longer axes finally lay at right angles to the line of action of the compressing force. The planes of cleavage are thus defined as the planes in which the particles of matter now extend their longer axes. Men of science, assuming *a priori* the truth of this theory, and employing artificial agencies, have produced distinct planes of cleavage even in such an unpromising substance as plastic clay. The theory of cleavage propounded by the geologists cannot, therefore, be dismissed as a pure speculation. It is supported by such evidence as the nature of the case either permits or requires. And therefore, we may, so far as the normal case is concerned, conclude that the planes of cleavage in the coal below and in the roof above strike in the same general direction.

A little reflection will show that this theory of the cleavage, in conjunction with the theory of roof-action herein explained, sufficiently account for the wellknown fact that the coal, as a general experience, is more easily got by the miner when the direction of the working is at right angles with the direction of the cleavage. Several of the most notable roof-troubles frequently met with are explained, and their remedy, or remedies, indicated by the same principles. It may first be shown why the coal is more easily won in the working which advances directly across the cleavage.

Advancing directly across the cleavage, the coal is more easily got by the miner because:—

(1) The planes of cleavage in the overlying strata, running continuously along the face-line, and in planes continuously parallel thereto, afford, as lines of least resistance to fracture, their maximum assistance to the vertical component of the roof-action.

(2) Because the natural compression of the strata being greatest along the line of the force which produced the cleavage-planes, the relief of compression is greatest along that line when falls occur in the goaf behind. Hence the lateral thrust of the strata, due to the relief of the compression, the thrust which gives birth to the horizontal component of the roof-action —the thrust which produces the draw at the surface and "mangles" the coal below, is greatest in magnitude and richest in power when the direction of working is at right angles to the line of cleavage.

(3) Because both components being at their maximum value, the total roof-action is a maximum also.

(4) Because the compression of the coal itself is greatest in the line at right angles to the cleavage, and the coal is thus more likely (on its own account) to burst out from the face in such circumstances.

(5) And finally, whilst, in the circumstances supposed, the horizontal component of the roof-action is of maximum power, the resistance of the coal, from the standpoint of its structure, is at its minimum value. For the planes of cleavage divide the coal into a number of vertical slices. These run parallel with the face-line, and have no lateral support at that line. Hence the oblique roof-action attacks the slices on their sides, where they are least able to resist attack. See Fig. 7 (Plate XI.), where the arrow, A, may denote the direction of the roof-action, the vertical lines representing the planes of cleavage, and the horizontal lines the planes of stratification. If, however, we advance in the same line as the cleavage, all the vertical slices of coal receive mutual lateral support, the roof-action is less oblique, and it only strikes the slices in the direction of their lengths, in which direction their resistance is evidently much greater, as will be apparent on reference to Fig. 8. It is therefore small wonder that most mining men prefer, if possible, to advance their longwall working directly across the cleavage.

In some cases, however, it is found undesirable to advance in this particular direction. The factors above-named may, in cases, develop more power than is desired, crushing the coal unduly, and producing an altogether abnormal proportion of slack, or pulverized coal. On the other hand, the development of excessive power may, even in this direction, overreach its object, and actually render the coal more difficult to win. This phase of the problem, however, is best considered along with the roof-trouble with which it is usually associated.

The roof-action set up in advancing at right angles to the cleavage may overreach its object in the following manner. Where the cleavage-planes are very fully developed, the disturbance may be so violent as literally to break off the roof at the face-line. In such an instance, the coal is at once relieved of much of the weight. Already disturbed by the pressure, then losing such pressure, and also, it may be, drained of its compressed gases, the coal becomes abnormally tough—the miner calls it "winded"—and correspondingly difficult to win. This toughness continues until the further advance of the face develops a new "weighting," which, of course, may expend its energy in the same violent manner as its predecessor, and with the same disastrous effects on the coal and on the timber along the face of work.

In any case, it will be evident that where the planes of cleavage are well developed in the rocks, the securing of the face of work will involve a larger cost in timber when advancing across the cleavage. For the vertical slices of roof-strata then run from end to end of the face of work. They are, therefore, very liable to give way at the first joint of stratification above the roof-line, and a very liberal expenditure of timber is required in order to maintain the standard of safety. When the direction of working, however, is in the same line as the cleavage, the situation is different. The vertical slices of roof-strata then merely bridge the shorter span across the face of work, being supported by the coal-head on one side and the packs on the other. They are not, therefore, so liable to give way at the first joint, or at the first plane of stratification above the roof-line. In the case described, it may, of course, be wise to think twice before finally adopting the favourite direction of working.

Control by Mode of Working.—It has already been noted that the roof-action on a (presumably straight) longwall face, advancing directly across the cleavage, may, in cases, be so unduly violent as repeatedly to break the roof clean off at the face-line. If this cannot be remedied or prevented by ordinary means, such as the institution of more efficient packing, etc., one radical remedy is to alter the direction of working and advance at a lesser angle with the cleavage. Such a remedy is usually effective, but it possesses its own share of disadvantages. There is, however, another method of cure. Instead of advancing a single long line of face, we may, without altering the direction of working, evade the surplus power of the roof-action by installing a system of shorter working-faces which follow each other at stated intervals. Such a system is often called the "step-system," "longwall by steps," or "stepped longwall." It is illustrated in plan by Fig. 9 (Plate XI.), and it has often proved successful where a bad roof appeared to render the operation of the long, straight face a practical impossibility.

Referring to Fig. 9, each short working-face is 12 yards long, and it leads the face next behind by the same distance. In practice, the lengths of face and amounts of lead show some considerable variation between one colliery and another. Viewing the step-system as a weapon of roof-control, its efficiency is easily accounted for. Taking as an example the case illustrated by Fig. 9, it is seen that whilst each man works on a "bord-ways" face of coal 12 yards in length, he continually leaves on his right-hand side a "head-ways" or "end-on" face of coal of similar length. The "bord-ways" face is the working-face; and the headways-face, in mining idiom, is simply the "wall-side." The roof-action, however, takes no account of such distinctions, but is exerted on both faces alike. If the bord-ways face existed alone, the draw at the surface would be projected forward in a line at right angles to this face. On the other hand, if the wall-side, or "end-on" face alone existed, the draw at the surface would be projected in a line at right angles to the vertical plane of the wall-side. But since both faces co-exist together, the respective draws due to one and to the other become the rectangular components of a resultant draw the direction of which is at right angles to the vertical plane of what we may call the "mean face-line."

Thus, in Fig. 9, the mean face-line is on the line AB, and the direction of the resultant draw at right angles thereto is shown by the arrows, *a*, *b*, *c* and *d*. Now, the projection of this resultant draw, and the projection of the total roof-action on the horizontal plane, represent forces acting in the same line but in opposite directions. Hence, since the arrows *a*, *b*, *c* and *d*, show the direction of the draw, the arrows, *x*, *y* and *z*, show the direction of the roof-action in the horizontal plane. It will thus be noticed that whilst each man works on a face of coal which advances directly across the lines of cleavage, the action of the great body of roof is directed upon a mean face-line which crosses the cleavage at an angle of 45 degrees only. Hence, considering this system of "stepped longwall" purely as a weapon of roof-control, its efficiency arises from the fact that the roof is here controlled by the angle which the cleavage-line makes with the mean face-line; and not by the angle that it makes with the direction of working. And it is clear that the angle at which the mean face-line crosses the cleavage-line may be made as large or as small as we please, by merely varying, as the circumstances may dictate, the numerical ratio which obtains between the width of each face and the length of its lead. Similar principles apply in the cases of some other so-called modifications of true longwall.

Where a roof is very bad, and the seam of coal is some 10 or 12 inches thicker than the height of the tub, or mine-wagon, the system illustrated in Figs. 10 and 11 (Plate XII.) may sometimes be adopted with advantage. It is, in effect, the same case as that of Fig. 9 (Plate XI.), only that the faces of work may be still shorter and the leads still longer. The men work on the "bord-ways" faces of the "lifts," which may be from 6 to 9 yards wide. These lifts are advanced at right angles to the line of the pack-walls which sustain the gateways through the goaf. They are timbered by a double row of stout props along the tub-way (which is carried close to the wall-side) and by temporary timber which is drawn out from behind the double row of props as the lift advances, leaving only enough of it next the face to protect the men—the transmission of pressure from the goaf being thereby reduced. As the lift continually advances, the roof is thus allowed to fall freely behind the double row of props and behind the men. As soon as a lift crosses the line of the next

gateway, it is worked from that gateway, the pack-walls being brought up to within a few feet of the wall-side. The double row of timber left behind is then drawn out and recovered. In the ideal arrangement, all the lifts reach their objective gateways simultaneously, each lift requiring the use of a fresh gateway just when the lift immediately preceding is done with it. The gateroads may be from 30 to 60 yards apart. The crosses show the method of timbering, so far as the propping is concerned. No brushing or ripping is required in the temporary tub-roads between the pairs of gateways.

Control by Rate of Advance.—In most longwall workings, the time-element has an important bearing on the control of the roof-action. The action of the roof does not come to a sudden stop when the men cease working at the close of the shift, neither is it immediately and appreciably accelerated on the recommencement of work next morning. In fact, it would appear that whilst the men continue working the venue of the action is being largely shifted forward; when they cease working, the action, from a practical point of view, concentrates its power upon the making of definite fractures at the face-line. Even in bord-and-pillar workings, we remove the "stook," or last remnant of the pillar, as rapidly as possible, knowing that a leisurely rate of working will probably result in the stook being smothered by the roof before the coal is secured. And in most mining systems, longwall or what not, if a stoppage occurs from any cause, such as a strike, we invariably find, on re-entering the mine, that, although the men have been on strike for so many weeks, the roof-action has been at work all the time, rendering necessary the execution of extensive repairs before any resumption of coal-getting can be made.

It is therefore evident that we may find a weapon of roof-control, not only in the direction of working, but also in the rate of working. Suppose, for instance, that the safety of the face of work demands its efficient timbering for at least 4 yards behind the face-line. Then, it is clear that each prop must stand for the same length of time as that required to advance the working 4 yards. Thus each prop must stand the pressure for a length of time which is measured inversely by the rate of advance. If the rate be doubled, the time of advance through

4 yards will be halved. Similarly, if the time occupied by the travel of the face through, say, 30 yards, be sufficient to so settle the roof-body that the cross-gate is then "worn-out," the result is that a new cross-gate must be made every 30 yards. But if the rate of advance be accelerated, the efficiency of each cross-gate will be increased. The increase of the rate of advance will allow the spacing of the cross-gates at longer intervals. It may not much affect the life of each individual cross-gate, but it will certainly affect the total number of cross-gates requiring to be made in each square mile of royalty. These are illustrations of the principle embodied in the rate at which the longwall face advances, and the principle itself can be studied from many standpoints, in addition to the two above occupied.

The rate of advance may be accelerated by putting more men on a given length of face. Or, what amounts to the same thing, it may be accelerated by freeing the nominal coal-getters from all duties beyond actual coal-getting—all other operations, such as ripping, brushing, packing, timber-drawing, etc., being entrusted to other classes of workmen, who should discharge these duties at night-time. The "stall-man," who is partly a hewer, partly a shifter, and partly a deputy, scarcely represents the system most favourable to rapid advance. In some cases, again, the rate of advance may be considerably augmented by the use of coal-cutting machinery. And, finally, in every system of longwall, the rate of advance will the more nearly approach the practical maximum for each system accordingly as the proportion of work paid for "by piece" exceeds the proportion paid for "by time."

Control by Arrangement of Pack-walls.—It is not necessary to refer to this item otherwise than briefly. Scarcely anything has been more fully studied by the average practical man than the proper arrangement and construction of his pack-walls; therefore scarcely anything is better understood by him, and it behoves one to be very careful not to say too much to him on the subject. The average practical man will therefore kindly understand that the following observations are made by way of quoting him, and not by way of teaching, or attempting to teach, him anything about the matter. Briefly, then, it is an

axiom of his that to keep the weight on the coal, you must keep the packs well up to the face of the coal. Also, the greater the width of the packs, and the closer they range in parallel lines, the greater is the efficiency of the arrangement with respect to the object named. Cross-walls, properly tied into the longitudinal walls of each pack, and at sufficiently frequent intervals, are valuable by reason of their tying effect and their greater or lesser efficiency to prevent the bulging of the longitudinal walls. For obvious reasons, the width of the pack should be greater where the height of the seam is greater: and the minimum width, in seams less than 30 inches thick, should not be taken as under 6 feet. In longwall workings, the packs stand in the place of the pillars formed in the first working of the bord-and-pillar system: and, to a large extent the same rule applies in both cases, namely, the creep in the roads will be less as the dimensions of the pack (or the pillar, as the case may be) are greater: and *vice versa*. Where the roof-stratum is very thick and strong, the packs should also be of very strong and substantial construction and dimensions: for, in such a case, the packs must sustain (at least for a time) the entire weight of the roof-body, and offer a resistance sufficiently rigid to enable the strong roof-stratum to break itself off finally in the goaf. On the other hand, when the roof-stratum is fragile, and the strata for a considerable distance above it fall freely into the goaf behind the packs, the goaf speedily becomes choked, by reason of the simple fact that any given weight of the fallen rock cannot, from any practical standpoint, be compressed into a space equal to that which the given weight of rock occupied *in situ*. The result of this fact is that much of the pressure is now transmitted through the fallen débris to the floor on which it lies; the pressure on the artificial packs is thus greatly relieved, and it is not necessary to build them of such substantial dimensions as those required where the roof is stronger. It will be seen that, under the softer roof, it is not the mere artificial pack of the longwall system which corresponds to the "pillar" of the bord-and-pillar system. In the case of the stronger roof, without a doubt, the analogy is to some considerable degree along those lines. But, under the softer roof, the dimensions of our analogous "pillar" are more truly defined by the area of the parallelogram formed by two lines, namely:—

The distance separating each pair of cross-gates, and the distance separating each pair of ordinary gateroads. The artificial pack runs round this area as a double wall, but the great body of area enclosed in the parallelogram has been "packed" by natural means—by the law of falling bodies, in fact, and by the falling bodies themselves. The "pillar," however, is none the less efficient on that account. That is to say, the natural filling is probably quite as efficient as the artificial filling. Of course, neither the one nor the other can ever form a pillar as unyielding as a natural coal-pillar of equal dimensions. But both alike possess a measure of ability to delay the descent of the great roof-body; both tend to modify the magnitude of the vertical component of the total roof-action; and in so far as they do this, they coincidently tend to accentuate the obliquity of the total action—the preservation of which obliquity it is the chief object of roof-control to secure.

Where the roof is excessively strong, and the packed roads a considerable distance apart, it may become necessary to build butts, or stone pillars about 4 yards square, at intervals along the working face. Such a roof will hang a long time and for a considerable distance into the goaf; but when at last it does break itself off, it will probably carry all before it, unless the face of work be fortified in some such way. Such a system of packing is sometimes called the "checker" system, from its fancied resemblance to the board on which the game of draughts is played (see Fig. 12, Plate XII.). With such an unduly strong roof, however, it is questionable if pure longwall is the best system to adopt for winning the coal—unless, indeed, the seam contains a thick stone-band, or a number of thinner bands, sufficient to pack thoroughly a large proportion of the gob.

It may here be remarked that the successful working of longwall demands a roof only moderately strong. Extremes in either direction are baneful, notwithstanding the assertion so frequently made in the textbooks that "longwall working requires a very strong roof." As a matter of fact, a very strong roof is more difficult to control than a roof which is distinctly tender. And if the seam be thick, and free from dirt-partings, such a roof may render any system of pure longwall a wholly objectionable mode of working, so far as the winning of that particular seam is concerned. Of course, if the roof were

infinitely strong instead of being only very strong, it would make all the difference: for, in that event, the roof would never break away at all.

Control by Arrangement of Roads.—After a pure longwall system has been opened up, it will often be found that the roads proceeding in one particular direction are more difficult to maintain than roads which proceed in other directions. Sometimes this is due to the particular angle (if any) made with the line of cleavage; sometimes it arises from the angle that these roads make with the line of dip; and sometimes, again, it may be due to the angle made with the strike of abnormal lines of reduced resistance to fracture in the roof-strata. In other cases, indeed, the cause of the evil encountered by roads proceeding in one particular direction may be as obscure as the effects themselves are obvious. Quite frequently, however, the difficulty may be surmounted, or, to speak more accurately, evaded, without entailing serious inconvenience. For it is usually practicable to deflect the class of roads thus affected into a different direction, along which the conditions may be more favourable. In fact, in a pure longwall system there are only one or two roads—the mother-gate and the main return airways—that we are bound to carry in one particular direction. These must evidently follow the direction of working. All the minor roads, however, may be deflected through considerable angles.

For example, let the bearing of the main mother-gate be zero or 0°. Suppose, then, that the obnoxious direction above alluded to lies in the bearing of 90°. Then the arrangement of roads shown in the skeleton plan (Fig. 13, Plate XII.) might be adopted, for in this arrangement, no roads bear at an angle of 90°. Suppose, however, that the obnoxious line lies in the direction of working. Then the arrangement of Fig. 14 (Plate XII.) may be adopted, and all the minor roads will make angles with the undesirable line. And finally, if the obnoxious bearing be neither 0° nor 90°, but along some intermediate line, the arrangement illustrated in Fig. 15 (Plate XII.) would probably answer, for all the roads proceed either in the bearing the angle of which is 0° or in that the angle of which is 90°. Of course such a dodging of the roof-action is not control from the

etymological standpoint, but from the practical standpoint it amounts to precisely the same thing. The results obtained are those desired.

Sometimes, again, apart from its angular bearing, the position of a road may be ill-chosen. For example, it is a mistake to run a gob-road close to a solid wall of coal. The road-roof sinks on the pack at one side and on the other breaks off clean at the coal-edge, owing to the resistance of the solid coal *in situ* being much greater than that of the artificial pack. A gully is thus formed in the roof and runs from one end of the road to the other. Such a result is pictured in Fig. 16 (Plate XII.). The roads most apt to be thoughtlessly placed in such positions are, perhaps, the initial cross-gates and the gate-roads leading to the two extremities of the face of work. These may subsequently furnish large portions of the main return-airways, so that the oversight becomes doubly unfortunate, both from the standpoint of safety and from the standpoint of cost of maintenance.

The correct site for the road is shown in Fig. 17 (Plate XII.). Here, the road lies at least 4 or 5 yards from the solid coal, the intervening space being properly packed. The roof, of course, still breaks off at the coal-line, but no longer shatters the roof of the road, the resistance at each side of the road now being equalized.

Control by System of Timbering.—The general principles of mine-timbering apply over a much wider area than the longwall workings with which alone this paper is concerned. Reference is therefore required only to such principles of timbering as require more especial study in longwall than in other mine-workings. And probably there is only one main principle which really comes within this category. This principle recognizes: (1) That the timbering must be capable of sustaining the weight of what has herein been called the roof-stratum. This refers to the strength of the timber. (2) That the timbering must be capable of maintaining the roof-stratum in position, notwithstanding the mechanical disintegration of that stratum. This means that the timbering must be sufficiently close. (3) That the timbering should readily yield (without breaking) to the irresistible pressure and motion of the great roof-body.

No. (2) needs no amplification. No. 1 states that the timber should be sufficiently strong, and No. 3 states that it should be sufficiently elastic. For the roof-stratum must be maintained in position, whilst the whole body of roof descends, it may be, through a distance of several inches. The ideal prop to answer this two-fold purpose would be a telescopic steel-prop in two or more sections—the sections sliding on each other against powerful steel-springs within—the springs being able to sustain a pressure of several tons. Such a prop would sustain the roof-stratum and also yield, without loss of efficiency, to the gradual descent of the body of roof. Such a prop is not yet forthcoming, however, and other means must be resorted to. Any ordinary pit-prop, standing by itself, will only yield to the irresistible pressure by breaking, after which, of course, it is not of further value in either of the directions indicated.

Since we cannot get a prop at once sufficiently strong and sufficiently elastic to answer our double object, we must fall back on a system of timberings. The only way known to the writer by which this double purpose may be attained with any degree of success is to employ tapered or "chamfered" props, resting on thick soles, and capped by substantial lids. The soles may further be bedded on a thin layer of dirt. As the roof slowly descends, the prop-head is forced through its lid, the foot is forced through the sole, the layer of mine-dirt is ground out, and the prop itself "burrs" or spreads out its fibres at either end. The roof may thus sink through several inches without breaking the prop itself, and without appreciably diminishing its efficiency as a support of the disintegrated roof-stratum. Such systems of timbering have recently been described and illustrated very fully in the *Transactions of the Institution of Mining Engineers*, to which enquirers are referred for further particulars.

As for the timbering of main roads, especially main return-airways, it is possible that the Gothic or "herring-bone" system of timbering a bad roof is not appreciated as fully as it deserves. In all main return-airways, a liberal height should be made in each section before the face leaves it far behind. A second set of rippings is undesirable. In fiery mines, the blasting in such return-airways is objectionable, and in any mine whatever, one does not want to carry the débris thus made a mile before finding

a place wherein to stow it. The height should be made at first and once for all, the return-airway should be temporarily timbered, and then left until the strata have comparatively settled. By this time, the roof of the return-airway, in one section after another, will have assumed the form of a natural arch (Fig. 18, Plate XII.). Each of these sections should then be dealt with in the following manner:—Without shearing back the sides—an operation which always invites fresh falls along the centre-line—the section should be timbered as illustrated in Fig. 17. Firstly, the dirt which has crumbled from the roof is levelled down—the liberal height previously made doing away with the necessity of carrying it out of the return-airway. Secondly, the soles, *a* and *a*, being firmly embedded in and upon the dirt-stratum thus obtained, and secured in position by flat stones *d*, *d*, *d* . . . set up edgewise in the dirt-stratum, vertical props are placed thereon to receive the longitudinal timbers, *b* and *b*, each of these being 8 or 9 feet long. Another longitudinal timber, *c*, of equal length or a little more, is then raised and temporarily supported on a "middle" prop. The diagonal struts, connecting *b* and *b* with *c*, are then placed and carefully wedged in position. Each set of vertical and diagonal timbers must lie in the same vertical plane, and there should be at least three sets of these along each set of longitudinal timbers. Lagging sufficient to make solid the resistance in the various lines of thrust is then inserted, the middle prop supporting *c* is removed, and the erection of the next set commenced with. Such a method of timbering is hardly as expensive as it looks; for the vertical and diagonal timbers may frequently be cut from bigger timber which has been broken in the main haulage-road; besides which, the vertical props and the soles, *a* and *a*, may quite frequently be entirely dispensed with by the exercise of a little ingenuity. In drawing Fig. 18 (Plate XII.), it was assumed that the roof had fallen in such a manner that the diagonal struts required to incline at an angle of 45° from the horizontal. Other circumstances, of course, might require a much smaller inclination, say along *b c*, as shown in Fig. 18, by the lower and more faintly-outlined struts. But whatever the angle, the ultimate strength of such a system of timbering is obvious, and its great elasticity under pressure is not less manifest. Even though the first cost be a little heavy, the system is a cheap one

in the end, for, to use the idiom of the engineer, it makes "an everlasting job."

Conclusion. The paper is concluded, but the subject is very far from being exhausted. Had opportunity permitted, the writer would have very much liked to refer to one or two other matters. However, it is hoped that the paper, even in its present imperfect form, may furnish some little food for reflection on this very important subject of the action, influence and control of the roof in longwall workings.

List of Illustrations (Plates XI. and XII.).

Fig. 1 illustrates the phenomena of subsidence and draw at the surface, as produced by mining operations below. The original profile of the surface is shown by the dotted line A B C, and the profile of the subsided surface by A H C. The line B E E_1 is in the vertical plane of the working-face, and G F F_1 is in the vertical plane of the solid coal-face left behind at the commencement of operations. A B is the draw on the surface beyond the working-face, and G C the draw extending over the solid coal left in the rear. The oblique line C D D_1 is that referred to in the text as the incipient hade-line. As drawn in the figure, it takes no account of the disparity of the vertical and horizontal scales, the angle C D M being shown at something like a normal value. It correlates the mining subsidence with the natural subsidence associated with the normal fault, and it suggests that the great lines of fracture in the mine-roof must practically lie at the angle indicated by the incipient hade.

Figs. 2 to 4 illustrate roof-fractures, and the influence of their obliquity on leverage and transmission of pressure.

Fig. 5 illustrates the probable philosophy of a "bending" roof. The roof, originally on the line D E, bends by steps, *a*, *b*, *c*, *d*, etc., into the parabolic curve, D F. A B is the vertical plane of the working-face, and B C the direction of advance. The pack-walls are not indicated.

Fig. 6 illustrates the effect of the pressure of the roof on the gate-roads, the original cross-section A B C D being reduced by pressure to E F G H.

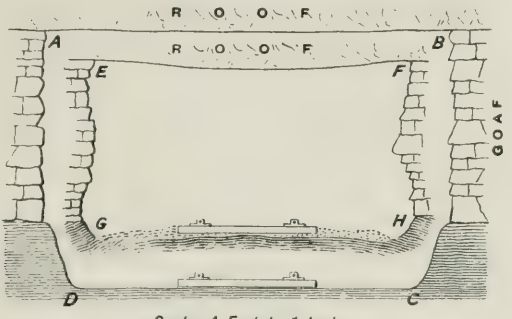
Figs. 7 and 8 illustrate the difference of the resistance offered by the coal to the oblique roof-action, according as the direction of working is across the planes of cleavage or in the same line.

Figs. 9 to 12 illustrate modifications, so-called, of longwall, the object of which is to evade the most violent effects of excessive roof-action, by directing such action on to a "mean face-line" which intersects the line of the actual working-face at a considerable angle.

Figs. 13 to 17 illustrate arrangements of roads designed to evade particularly obnoxious developments of the roof-action.

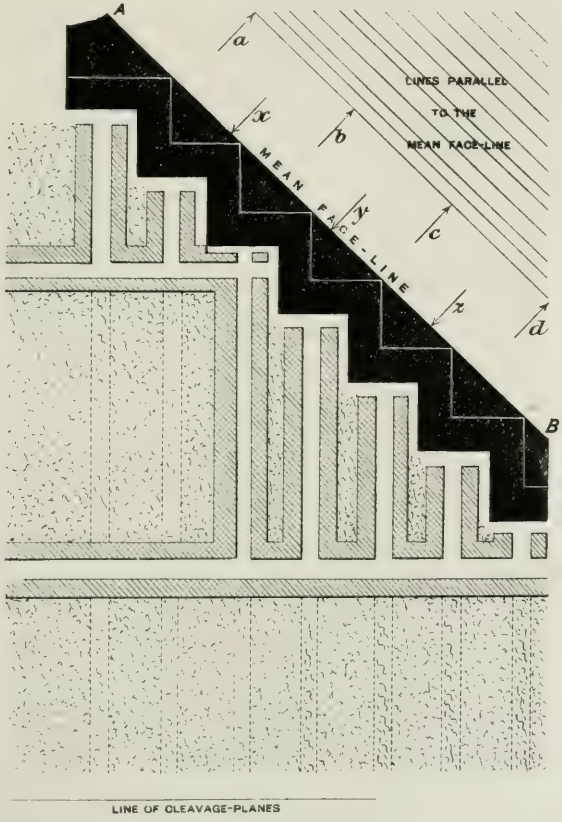
Fig. 18 illustrates the Gothic or herring-bone system of timbering a main return-air way, carried through the gob, and under a bad roof.

FIG. 6.—TRANSVERSE SECTIONS OF GATEWAY.



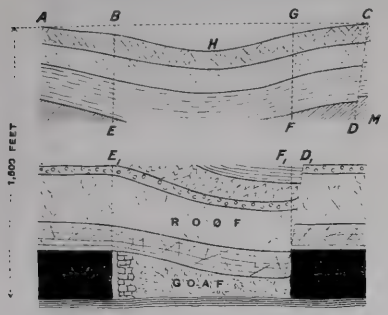
Scale, 4 Feet to 1 Inch.

FIG. 9.—PLAN OF GATEWAYS.



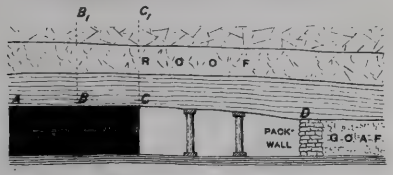
Scale, 100 Feet to 1 Inch.

FIG. 1.—SECTION OF STRATA THROUGH THE VERTICAL PLANE OF THE WORKING-FACES.



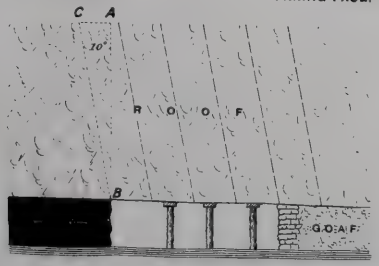
Vertical Scale, 16 Feet to 1 Inch.
Horizontal Scale, 400 Feet to 1 Inch.

FIG. 2.—SECTION THROUGH THE WORKING-FACE.



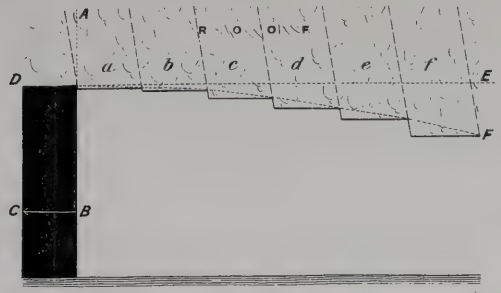
Scale, 16 Feet to 1 Inch.

FIG. 3.—SECTION THROUGH THE WORKING-FACE.



Scale, 16 Feet to 1 Inch.

FIG. 5.—SECTION THROUGH THE WORKING-FACE.



Scale, 4 Feet to 1 Inch.

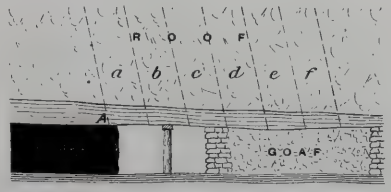
FIG. 7.—SECTION THROUGH THE WORKING-FACE, CROSSING THE CLEAVAGE-PLANES.

Scale, 16 Feet to 1 Inch.

FIG. 8.—SECTION THROUGH THE WORKING-FACE, PARALLEL WITH THE CLEAVAGE-PLANES.

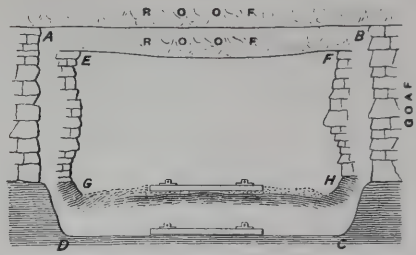
Scale, 16 Feet to 1 Inch.

FIG. 4.—SECTION THROUGH THE WORKING-FACE.



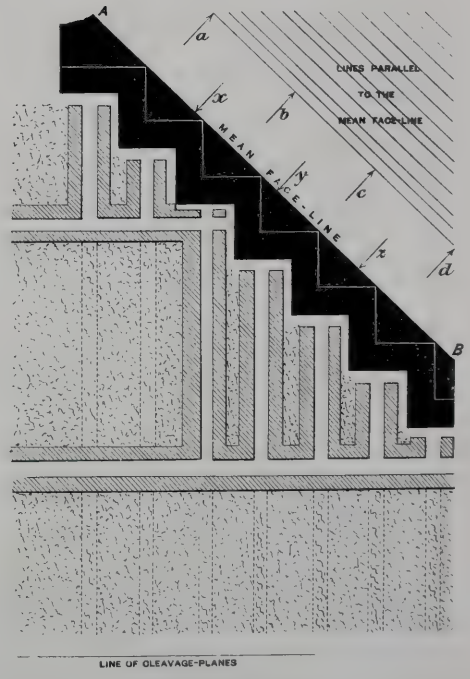
Scale, 16 Feet to 1 Inch.

FIG. 6.—TRANSVERSE SECTIONS OF GATEWAY.



Scale, 4 Feet to 1 Inch.

FIG. 9.—PLAN OF GATEWAYS.



Scale, 100 Feet to 1 Inch.

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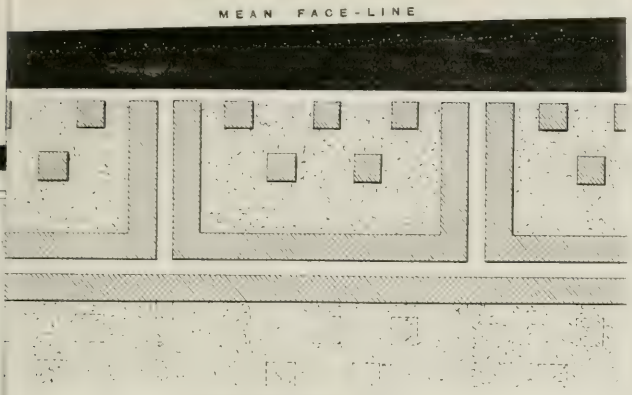
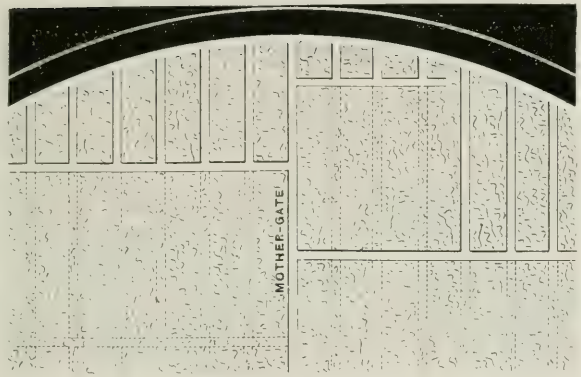
FIG. 12.—PLAN OF GATEWAYS.



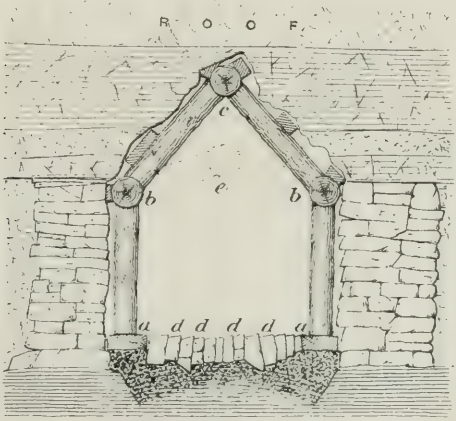
Scale, 100 Feet to 1 Inch.

FIG. 15.—PLAN OF GATEWAYS.



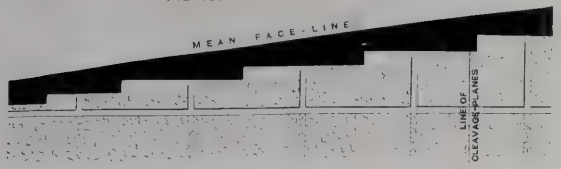
Scale, 200 Feet to 1 Inch.

FIG. 18.—SECTION THROUGH A GOAF-ROAD.



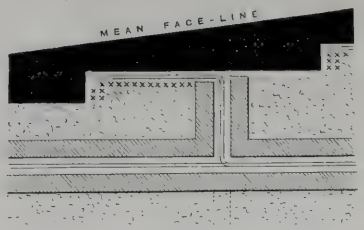
Scale, 4 Feet to 1 Inch.

Fig. 10.—Plan of Gateways.



Scale, 200 Feet to 1 Inch.

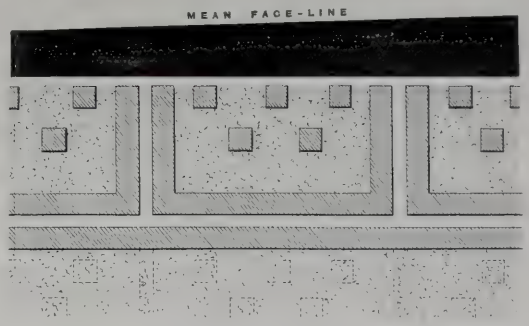
Fig. 11.—Plan of a Gateway.



Tramway.
Timber.

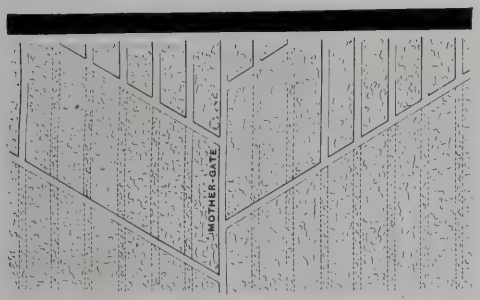
Scale, 100 Feet to 1 Inch.

Fig. 12.—Plan of Gateways.



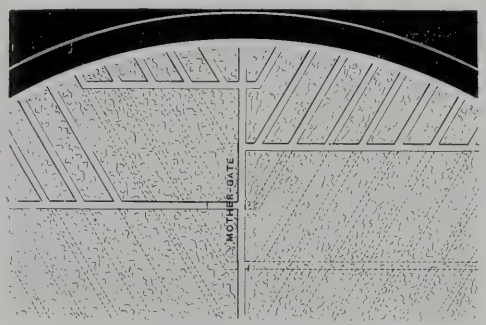
Scale, 100 Feet to 1 Inch.

Fig. 13.—Plan of Gateways



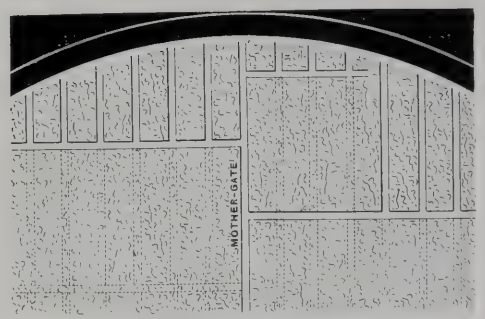
Scale, 200 Feet to 1 Inch.

Fig. 14.—Plan of Gateways.



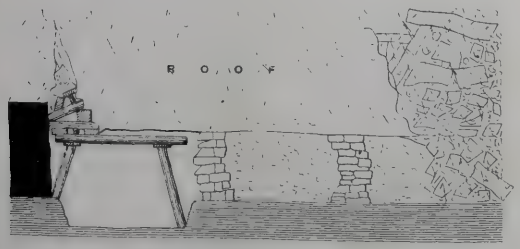
Scale, 200 Feet to 1 Inch.

Fig. 15.—Plan of Gateways.



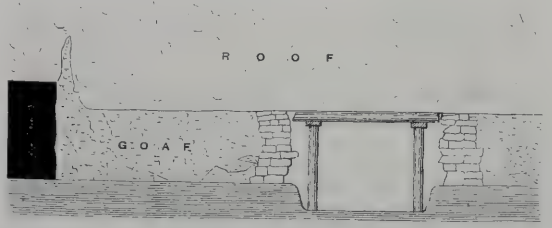
Scale, 200 Feet to 1 Inch.

Fig. 16.—Section through a Goaf-road.



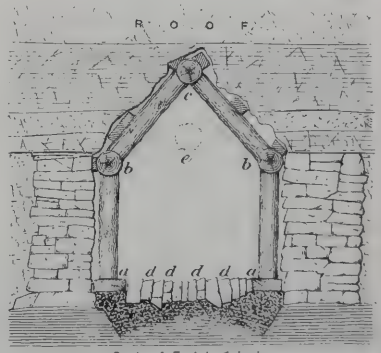
Scale, 8 Feet to 1 Inch.

Fig. 17.—Section through a Goaf-road



Scale, 8 Feet to 1 Inch.

Fig. 18.—Section through a Goaf-road.



Scale, 4 Feet to 1 Inch.

DISCUSSION OF MR. T. E. PARRINGTON'S PAPER ON "THE ADOPTION OF A BALANCE-ROPE AT HYLTON COLLIERY."*

Mr. John Morison referred to the discussion which took place at the previous meeting on this subject, when the question was raised by Mr. A. L. Steavenson as to the effect of over-balancing a winding-rope, by some means which he did not suggest.† An interesting discussion arose, in which Mr. W. C. Blackett referred to a tapered rope which Mr. John Daglish had projected for balancing the Silksworth winding-engine in 1879. Mr. W. C. Blackett and Mr. T. E. Forster, who were both conversant with Mr. Daglish's idea, referred at some length to the matter; and in the course of that discussion, he (Mr. Morison) said that a parallel rope, of the same weight as a tapered rope, would have as good an effect and in a simpler form. Mr. Blackett had supplied him with some figures with regard to the proposed Silksworth rope, and from these figures, he (Mr. Morison) had constructed a diagram (Plate XIII.) showing the effect of the tapered balance-rope as proposed by Mr. Daglish; also the effect of a balance-rope of the same weight made in the ordinary way, and the effect of the load without any balance-rope. The comparison between the tapered rope and the parallel rope showed that the weight assisting the winding-engine at the start ceased its effect at about the fifth revolution; and conversely in retarding the load, it began to come into effect at the fifth stroke from the end of the wind. An ordinary rope of the same gross weight would commence at the beginning of the wind with the same load assisting the engine, and would carry its assistance through to the meeting of the cages, and at meetings the reverse effect began to take place. In the diagram (Plate XIII.), more assistance was rendered to the engine from the commencement of the wind to meetings, an object which he did not think would be attained by using a tapered rope. He (Mr. Morison) agreed that it would be desirable to make the balance-rope a little heavier than the winding-rope. The weight of the winding-rope in the case referred to was 8,004 pounds, and of the counterbalance-rope 9,908 pounds. There was not much difference in the weights, but he thought

* *Trans. Inst. M.E.*, 1903, vol. xxvi., page 294. † *Ibid.*, page 298.

that the effect in winding would be improved by using a still heavier counterbalance-rope. He suggested that if a subject could be got, a diagram should be made in which the load put in motion by the engine should be plotted in a continuous line. He thought that it would be possible to construct such a diagram, and, coupled with the paper which had recently been read by Mr. Thacker on "The Dynamics of the Winding-engine," it would form a great advance in the knowledge of the operation of winding.

Mr. C. C. Leach agreed with Mr. Morison that the balance-rope should be heavier than the winding-rope. There was great loss in the winding-engine, and probably the first two or three revolutions used three-fourths of the total volume of steam used in a wind. He did not see any advantage in using a tapered balance-rope, as it was more desirable to overbalance than to balance the load.

Mr. W. C. Blackett stated that the proposed tapered balance-rope was heavier than the winding-rope, but the point under discussion was where the weight should be placed in the rope. The tapered balance-rope had the advantage because, in the first few strokes, it helped the load. The Silksworth engine ran for a long time, the pit being deep, and once started, there was no need to continue the assistance to meetings, but towards the beginning of the fifth stroke from the end, the weight of the tapered end of the balance-rope was brought into use to help to stop the ascending cage. Any member who wished to look more closely into this matter should read Mr. Daglish's paper.* It was written prior to the suggestion of tapered balance-ropes, when counterbalancing of the load was secured by the use of staples or conical drums.

Mr. C. C. Leach said that Mr. Blackett evidently desired to make the winding-engine run at a uniform pace, which could not be done.

Mr. Blackett replied that such was not his suggestion.

Mr. J. H. Merivale remarked that Mr. Blackett had simply spoken of the rope, but it was necessary to take the inertia and

* *Trans. N.E. Inst.*, 1876, vol. xxv., page 201.

momentum into account. Additional weight was required at the beginning, not only on account of the weight of the rope, but also on account of the inertia of the mass to be put into motion. The engine did not require the balance equally from the top to the bottom, but a little extra weight at the beginning of the wind to overcome the inertia, and a little extra weight against the engine at the end of the wind to overcome the momentum.

Mr. T. E. Forster said that he had made a diagram as well as Mr. Morison. He thought that theoretically Mr. Daglish's tapered balance-rope was a good suggestion, but the proposed rope was not made. He (Mr. T. E. Forster) found that several people used a balance-rope a little heavier than the winding-rope. It was an advantage, and he thought that if they made it about 10 per cent. heavier in the case of an ordinary shallow shaft, that would be about the best weight. In a pit, 2,580 feet deep, he was astonished to see what the winding-engine could do: the engine was not more than half the size of what they would put in now, and the balance-rope was of a form that he had not seen elsewhere: it was a flat one. The manager told him that he had found the advantage of using a flat rope was that it was not so lively as a round one, and it did not twist about in the shaft.

Mr. S. Hare said that at Murton colliery a flat balance-rope had been in use for many years with very little trouble. Once or twice some few years ago it kinked, but not recently. It was used at the shaft where the men were changed. Originally a guiding-pulley was used, but it had been taken out.

Mr. John Morison said that the point in dispute between Mr. Blackett and himself was not only as to whether the balance-rope should be heavier, but whether or not the tapered balance-rope was as good or better than the parallel balance-rope. He thought that the diagram (Plate XIII.) demonstrated that the parallel balance-rope was better than the tapered rope, which was so troublesome to design that it had never been made. He had seen many diagrams, and had many diagrams of winding-engines, and they were not all shallow pits; but he had never seen a diagram yet proving that it was advantageous to cut off

the assisting balance-rope at the fifth revolution, and he would like to see such a diagram. All the diagrams that he had seen showed that the engine required assistance from the start very nearly to meetings, and as soon as possible afterwards the balance-rope was used to retard the engine, and the further they carried it towards the meetings the better was the result. Every separate winding-engine would require a different arrangement of balance-rope. It would, to begin with, depend on the capacity of the engine for its load, and one might be economical where another was not; but he thought that he had demonstrated (at least to his own satisfaction, if not to Mr. Blackett's) that the parallel rope gave a better balance than any tapered rope that could be made.

Mr. W. C. Blackett said, with reference to the curved line, JNOK,* arranged by Mr. Daglish for the Silksworth engine, that it was at the fifth revolution that the assistance stopped. With the ordinary counterbalance, with chains hanging in a staple, the weight was removed at a certain part of the stroke to give the exact line which he had indicated, and the conical drum also was made to give that identical line. He was only putting forward what Mr. Daglish at that time considered would give the best possible result for the Silksworth winding-engine; and, if the members would follow out the subject, they would find that the engine was working economically after the fifth stroke. Mr. Morison's straight line was certainly against Mr. Daglish's theory and actual practice.

The President (Mr. W. O. Wood) said that he had had some experience with balance-ropes. About 30 years ago a winding-engine broke down, and by means of a balance-rope one cylinder was able to perform the work that the two had been doing. The tapered balance-rope was theoretically correct, but he thought that it would not answer in practice, as it would coil and kink. The flat balance-rope at Murton colliery worked beautifully for a year or two, and then, without any apparent reason, the rope would kink and twist and give a great deal of trouble. As Mr. Hare had said, there had not been the slightest trouble for the last two or three years, but it might go wrong any day.

* *Trans. N.E. Inst.*, 1876, vol. xxv., page 214, Plate LIV

THE FACTORS GIVEN FOR

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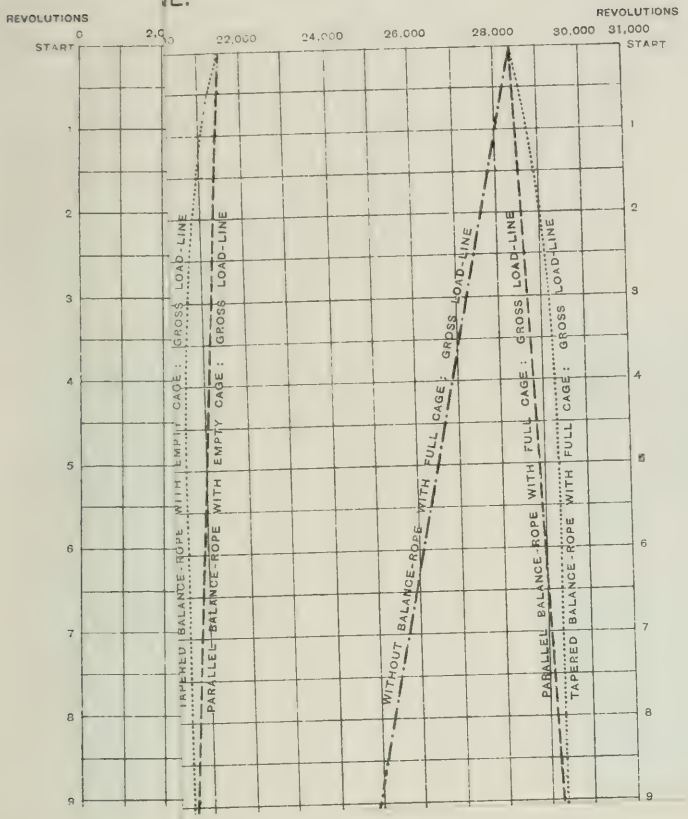
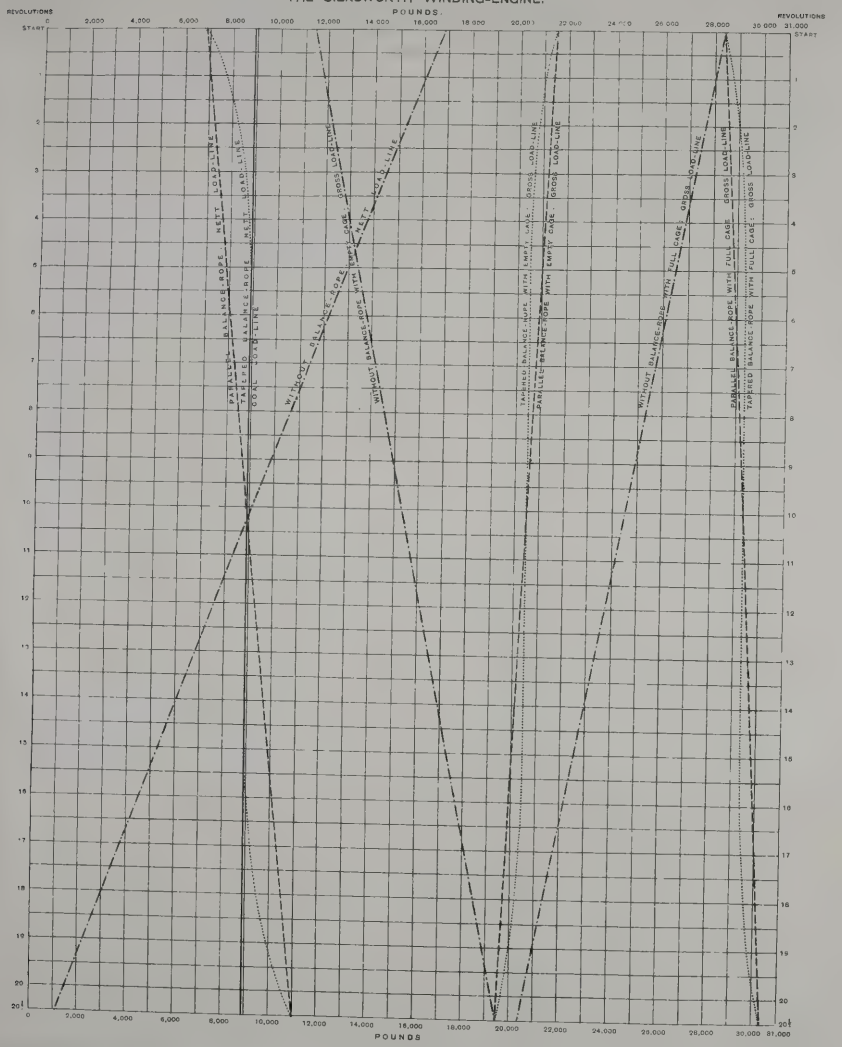


Diagram shewing the Load-lines calculated from the Factors given for the Silksworth Winding-engine.



Vol. LIV. Plate XI.

WELDLESS STEEL PIT-PROPS.

The Sommer prop for mines is made of two tubes, one telescoped into the other, thus enabling the prop to be lengthened or shortened as required. The two tubes are held in position by means of a clamp, which can be screwed together so as to carry a load varying from 15 to 16 tons without giving way. The clamp is placed upon and attached to the outer tube in such a way that it cannot slide downward. The heel of the lower tube is either made flat or pointed, or fitted with a base-plate suitable for a soft bottom-stone. The upper tube can be supplied either with a flat or semicircular end to receive a small wooden

Fig. 1.—Steel Pit-props.

block, whenever its use is found necessary. The props can easily be placed in position, after the proper length has been adjusted, in a similar way to wooden props.

The principal aim being to use these steel props over and over again, a special device has been adopted, so as to recover them after the coal has been worked out. The clamp is then loosened by means of a spanner or ratchet, and the latter can, if necessary, be worked with an iron-hook from a distance, so as to avoid danger (Fig. 1).

It is claimed that the Sommer steel props will never bend, break or collapse by upheavals of the bottom, or subsidence of the roof. In any case, where the maximum pressure of 16 tons is exceeded the upper tube will adjust itself, by automatically telescoping into the lower tube, and will remain stationary and intact as soon as the pressure abates. It is a common experience that wooden props break one after the other, thus gradually weakening the resistance until the entire roof collapses. Sommer steel props, however, will never act in this way; and if one prop is overloaded it will telescope sufficiently until the pressure is met by the other props and equally distributed.

The Sommer props are made 4 to 6 feet long, with tubes $2\frac{1}{2}$ and 3 inches in diameter; 6 to 9 feet long, with tubes 3 and $3\frac{1}{4}$ inches in diameter; 9 to 12 feet long, with tubes $3\frac{1}{4}$ and $3\frac{5}{8}$ inches in diameter; and 12 to 18 feet long, with tubes $4\frac{1}{8}$ and $4\frac{1}{4}$ inches in diameter. A steel prop, 7 feet long, weighs about 112 pounds.

DISCUSSION OF MR. J. J. MUIR'S PAPER ON "AN IMPROVED FORCED METHOD OF TREATMENT OF LOW-GRADE COPPER-ORES."*

Mr. H. Lipson Hancock (Moonta Mines, South Australia) wrote that he was struck with the percentage of the ore termed "low-grade," which would here be considered good grade. However, Mr. Muir did good service to the members by giving them the benefit of his investigations, and deserved their appreciation. If the ore in the material considered to be typical of Lyell, in Tasmania, is finely disseminated throughout the gangue containing 48 per cent. of silica, the process outlined should have much to recommend it, although he was rather doubtful whether the operation could be completed for 14s. per ton. Even accepting the figures quoted, the extraction of copper from a 3 per cent. ore, with a good extraction, would require an expenditure of £28 per ton of copper to bring it up to the precipitate form, and a further £3 per ton to make it into good metal, or a total cost of £31 per ton. It appeared to him (Mr. Hancock) that too little attention, in a general way, was paid to the possibilities of economical cracking, sorting and

* *Trans. Inst. M.E.*, 1903, vol. xxvi., page 40.

mechanical concentration, which with many Australian ores (where the specific gravity of the gangue was not more than 2·8 to 3), would often be found more easily applied, especially as there were so many minerals, which increased the quantity of acid required to dissolve the copper. As an instance of this, at Wallaroo mines, 3 per cent. sulphide ore is treated by mechanical dressing and smelting, and produces copper at a cost of about £26 per ton, as against the cost of applying Mr. Muir's process at a cost of £31 per ton of copper. If the ores at these mines were equal to an average of 4½ per cent. of copper, the Wallaroo mechanical processes combined with smelting would, he thought, be preferable from a commercial point of view to the process outlined in Mr. Muir's paper.

Mr. Walter T. Holberton (Copiapo, Chile) wrote that, although the principle on which Mr. Muir's method was based was by no means a new one, the paper was interesting; and if the process could be worked to be commercially successful, undoubtedly great benefit would be derived in localities where that class of ore, as described, was abundant. The method had been attempted in Chile locally, under various modified forms, with a view of profitably treating the large deposits of very low-grade carbonate ores, that existed throughout that country, by the treatment with sulphurous acid obtained from low-grade pyritic ores, but hitherto it had not been a commercial success. It seemed to him (Mr. Holberton) that Mr. Muir's deductions were made more from experiments than from treatment on a working scale, and, he feared that gentleman would find great difficulty in using the sulphurous fumes derived from the selected portion of the ores, when roasted in a reverberatory furnace, because the fumes would be mixed with the products of combustion of the fuel. When using a retort and compressed air, his expenditure would be high, but local conditions would have to be taken into consideration.

He (Mr. Muir) also stated that "in operation, it is advisable to have an excess of sulphurous acid (H_2SO_3) in the solution."* In actual practice he would find that it was not only advisable, but that it was absolutely necessary, because a certain amount of sulphite of copper was formed, which was not soluble in water but was so in a solution of sulphurous acid.

* *Trans. Inst. M.E.*, 1903, vol. xxvi., page 44.

He (Mr. Holberton) did not quite agree with Mr. Muir when he said that "it is also necessary . . . . . to show a speed in the work that will compare with that obtained in a smelting operation."* He could not see that great speed in treatment was necessary, so long as the capital required for the plant was not too great, and that a good profit was the result of the treatment. The Rio Tinto Company probably treated larger quantities of this class of poor ores than any other such undertaking in the world, by a process which required several months to treat a given pile of ore and yet they paid big dividends.

He thought that Mr. Muir was certainly on the right track, and that his investigations would be watched with considerable interest by the copper community. It was to be hoped that he would favour the members with further details, when his method had had a continuous trial on a working scale.

Mr. Luke Williams (Claremont, Tasmania) wrote that Mr. Muir estimated that the cost of treatment of crude schistose ores would be 14s. per ton, to this he would add from 3s. to 6s. per ton (according to the nature of the deposit) for mining charges, supervision and disposal of the products, the cost of treatment thus averaging about £1 per ton of crude ore. With copper at £50 per ton (and it was not safe to calculate on a higher value, when looking into the future of any new process) it would require 2 per cent. of copper in the crude ore to pay all expenses. He therefore thought that the cost of treatment must be reduced before the process could be extensively used, as the Mount Lyell mine had paid dividends by direct smelting of an ore containing only $2\frac{1}{4}$ per cent. of copper (with copper under £60 per ton), 2 ounces of silver and $1\frac{1}{2}$ to 2 dwts. of gold per ton. He considered that Mr. Muir was deserving of great credit for the work that he had done up to the present with his laboratory-tests of his process, and he (Mr. Williams) would like to see it in operation at some mine working on a commercial scale.

Mr. G. D. van Arsdale (New York City, U.S.A.), wrote that the process described by Mr. Muir, provided that he had overcome the mechanical and other difficulties hitherto attending the use of sulphur dioxide as a solvent, would seem to be adapted to

* *Trans. Inst. M.E.*, 1903, vol. xxvi., page 41.

the treatment of an ore of the analysis given, since it is claimed by those advocating similar methods that sulphur dioxide is not consumed to so great an extent as sulphuric acid in attacking soluble constituents, other than the copper, of an ore. Unless this particular ore contained them in a more or less insoluble state, the comparatively large amounts of lime, magnesia, etc., would practically prohibit leaching by ordinary methods. In certain cases, however, a choice of the proper strength of the solvent, is of importance, as certain magnesium-aluminium silicates are decomposed by stronger solvents in preference to the copper; while, with weaker solutions, the copper may be extracted without consuming too much of the reagent. Mr. Muir's conclusion as to the good extraction obtainable by most of the main processes proposed for copper-leaching, tended to show that probably most of these could be successfully applied under proper conditions, but that very few would prove economical under conditions of high cost of fuel, chemicals, including iron, etc. In considering a choice of processes, there are, besides costs and the chemical composition of the ore, sometimes other factors, difficult to determine by analysis or experiment on a small scale, that largely influence results. For example, experiments were made for the wet extraction of the copper from an ore of seemingly nearly identical composition with another, which was yielding good results on a large scale. The experiments did not succeed, although the reason for their failure could not be predicted from the chemical composition of the ore. He hoped that Mr. Muir would publish the results obtained on a large scale. It would be especially interesting to know whether he found in practice that the amount of sulphur contained in these ores was sufficient to effect the solution of their copper. Regarding the precipitation of the copper, it seems probable that Mr. Muir intends to make use of the reaction proposed in the Neill process (precipitation of the copper from solution as sulphite, by driving off the excess of sulphur dioxide) in addition to precipitation by iron, since otherwise the cost given by him for pig-iron would seem rather low, unless this was obtainable at a very low price. The leaching of copper, while entirely practicable, as shown by the large amounts annually extracted from the Spanish and Portuguese deposits and by the Henderson process, had not made the same progress as copper-smelting, possibly because of

the need for a more universally applicable process: but doubtless there would be applications made in the future, since there exist large deposits of ore only amenable to a wet process, and if Mr. Muir's work proved to be a positive step towards this end, he was to be congratulated.

APPENDICES.

I.—NOTES OF PAPERS ON THE WORKING OF MINES, METALLURGY, ETC., FROM THE TRANSACTIONS OF COLONIAL AND FOREIGN SOCIETIES AND COLONIAL AND FOREIGN PUBLICATIONS.

ANKYLOSTOMIASIS.

Ankylostomiasis: a Forewarning. *By* WALTER C. C. PAKES. *The Journal of the Chemical, Metallurgical and Mining Society of South Africa*, 1904, *vol. iv pages* 256-260.

Ankylostomiasis has in times past received different names, which to some extent show the sometimes peculiar distribution of the malady. For instance, it has been called "miners' anæmia," "tunnel-sickness," "brick-makers' disease," "Egyptian chlorosis," and (from the alternative name of the parasite) "uncinariasis."

This disease is by no means a new one, for Sandwith has shown, from an ancient Egyptian papyrus, that it was known 3,450 years ago; although in those days the then medicine-men ascribed the worms to the disease, and not the disease to the worms. No mention of the disease appears in medical writings between that date and 1648, when it was described in Brazil, and in the beginning of the eighteenth century, when it was recognized in Guiana. Only in 1841 did Dubini of Milan settle the parasitic nature of the disease. Pruner, in 1847, and Griesinger, in 1851, found the worms frequently in the dejecta of Egyptians, and in 1854 the latter and Bilharz showed the connection between this parasite and "Egyptian chlorosis." It was not, however, until the St. Gothard epidemic in 1880 that the disease was generally known, and the modern knowledge upon the subject dates from then. Since that date the disease has been found to exist almost throughout the known world, between 51° north latitude and 30° south latitude. It has been met with in Burmah, Ceylon, India, Assam, Malaya, Cochin China, China, Japan, Borneo, the West Indies, British Central Africa, Lagos, the Cape, and recent epidemics have occurred in England, Westphalia and Belgium.

It is quite evident, therefore, that from its geographical position, the Rand is not exempt. Further, when it is remembered that miners are drawn from all over the world and that it is known that the British Central African natives are often infected, there is no doubt of the possibility of the importation of this disease on the Rand. Take the British Central African natives alone; Daniells examined the dejecta of 251 natives, and found the eggs of the worm in 25, that is, 10 per cent. of the natives. As will be seen later, one person containing one impregnated female worm may carry sufficient ova to infect a whole community. The natives examined came from the Shiré, Angoni and M'langi Highlands, from Nyasa, and from both the Upper and Lower Shiré rivers.

In view of future possibilities, it is interesting to note that Preston Maxwell has found the worm common among the agriculturists of Southern China.

Lastly, Looss has shown that dogs may act as hosts for the parasites.

Briefly, the disease is one which is characterized by a progressive anæmia associated with irritation of the internal lining of the intestine, particularly of the second portion thereof. The symptoms are those of anæmia, together with those arising from the irritation of the worm. The anæmia is evidenced by pallor, breathlessness, dizziness, swelling of the feet, fainting, and so on, the symptoms, of course, varying with the degree of anæmia. The irritation of the intestine is evidenced by the pain over the stomach, ravenous and perverted appetite, and occasional hæmorrhage. Despite all the symptoms, the sufferer frequently does not waste if his food is plentiful; but, despite the plentiful food, he shows extreme pallor. More will be said of the symptoms later.

Whatever may be the predisposing causes of this disease, the one single causal factor is a nematode worm, to which various names have been given. It is known generally now as the *ankylostoma duodenale* (but has been called severally the *dochmius duodenalis*, *ankylostomum duodenale*, and *uncinaria duodenalis*). Being nematodes, that is, round or cylindrical worms, both sexes are represented. The adult female worm is about $\frac{1}{2}$ inch long and tapers; at the extreme end it is conical and bears a spine. The adult male worm is rather shorter than the female and has a very characteristic and unique caudal appendage. This consists of a large umbrella-like trilobed bursa or sac having eleven ribs, and from the cloaca at the bottom of the sac two long delicate spicules protrude. Thus an adult male is distinguished with ease and certainty. Both worms have a circular mouth supported on a tapering neck, which is furnished at the margin with four strong claw-like hooks, and two conical teeth. The anus in the male is terminal, and in the female subterminal. The vaginal orifice is situated at the junction of the middle and posterior thirds of the worm.

The life-cycle of the worm is as complicated as it is interesting. The impregnated female worm produces a prodigious and never-ending stream of ova or eggs. These eggs measure about $\frac{1}{400}$ inch by $\frac{1}{700}$ inch; they have a regular oval form, with a delicate and beautifully transparent shell, through which the yolk may be clearly seen, often distinctly segmented. In the intestinal canal of the host the ovum does not undergo further development. In the decomposing dejecta of a person harbouring this parasite, the whole process of hatching may be observed. The segmentation increases until a morula or mulberry-form is seen, and, finally, the embryo in the shell. The shell then bursts, and the embryo is set free. When newly hatched the free rhabdite form measures about $\frac{1}{112}$ inch in length and $\frac{1}{2000}$ inch in thickness.

When hatched, there is little to be seen of the internal structure except an intestine and œsophageal bulb. When kept at a temperature of 70° Fahr. in the dejecta, the worms grow about three times their original size in 48 hours, and during this time undergo about four moults. From now onwards the environment appears to determine which of two cycles the larva will adopt:—

(1) If at this stage the larva is introduced into the body of a suitable host, it develops into the sexually-mature adult worm, and the cycle is repeated. There seems evidence that if at this stage the dejecta or soil are partly desiccated, the young larva remains dormant for many months until a remoistening of the medium starts it once more into activity.

(2) If it remains in the moist dejecta it undergoes further moults, until after the lapse of from four days to a fortnight or so (according chiefly to the temperature), it becomes a sexually-mature free rhabdite. In this condition the male measures $\frac{1}{38}$ inch by $\frac{1}{1000}$ inch, and grows to $\frac{1}{24}$ inch by $\frac{1}{300}$ inch. The female may attain a size of $\frac{1}{15}$ inch by $\frac{1}{200}$ inch. After impregnation, the female in the free state probably lays a number of eggs somewhat similar to that produced by the parasitic worm. These eggs develop into free larvæ and adult free worms, and the cycle goes on until the environment is unfavourable, when the cycle is suspended. Whether these free forms are derived from the parasitic form directly, or from the free forms developed from the parasitic forms, does not seem to affect their potentiality for evil. To quote Giles: "The progeny of both develop into parasites or rhabdites, according to the environment in which they find themselves."

The length of time that they exist depends upon the suitability of the environment. Giles has succeeded in reviving the free-stage worms which were in the soil, and which had stood the desiccation of a Punjaub summer, even after the lapse of twelve months. Thus it will be seen that under unfavourable conditions, such as desiccated soil, the rhabdites can exist for many months in a dormant condition. Under favourable conditions they multiply enormously.

The conditions favourable to their development in the free form are moist, warm, organically-contaminated soil. This fact will explain how the disease has acquired two of its names, namely, "brickmakers' disease" and "tunnel-sickness," and will indicate the reasonableness of the term "miners' anæmia."

Giles, who has very carefully studied their extra-corporeal development, makes the emphatic statement that in ordinary water they not only do not develop, but slowly die for want of nourishment; further, he says that the water must be practically stagnant sewage to allow them to develop. This does not mean, however, that the infection cannot be carried by means of foul water, because, as he points out, the rhabdite dies out slowly; and it is quite possible for a rhabdite to be transferred by means of infected water to the intestinal canal, and even though it is slowly dying, the transfer to a suitable environment may result in its resuscitation.

Whether a particular free-form is capable of becoming parasitic appears to depend upon the age of the rhabdite; if it is sexually mature as a free worm, it is probable, from the evidence at hand, that it cannot become parasitic, but so long as it is in the sexually immature form it is capable of developing into the parasitic form.

The method of transfer to the human subject is obvious. The ground or mud is infected by human dejecta—a single dejection may contain thousands of eggs—a brickmaker or miner handles the soil, and carries infection into his intestinal canal while partaking of his food. In a mine, the boots and clothes collect the rhabdite-infected mud; from these to the hands is but a short distance, and from the hands to the mouth an equally short journey.

There is, however, another method of infection, namely, by the skin, chiefly through the hair-follicles. This method of infection was accidentally discovered by Looss, who was studying the worms, and who infected himself in this manner. It has been subsequently confirmed by Sandwith and others. What happens to the embryo when it has entered the skin, and whether it reaches the intestinal canal is unknown, but the fact has considerable bearing upon one of the symptoms which will be explained subsequently.

Arrived in the mouth, the young rhabdite quickly develops into the adult parasitic worm, and attaches itself to the coat of the intestinal canal by means of its powerful hooks. Fortunately, perhaps, as has been seen, the worm cannot produce other worms in the intestinal canal; the eggs must be hatched outside the body and produce the rhabdite form. In consequence, every adult worm present in the intestinal canal must have been ingested as the free form. This, as we shall see, is an important fact concerning the prevention of the disease. The possibilities of infection are, however, enormous. Suppose one person infected with ankylostomes were working in a mine where sanitary arrangements are not quite ideal, where the dejecta-infected soil is constantly moist, and where the temperature is 70° Fahr.; such a man might have twenty adult females, laying 500,000 eggs in the course of a few weeks. If 1 per cent. of these eggs hatched, we might expect 2,500 rhabdites of each sex. If we imagine that a small percentage of these become sexually mature in a fortnight, and reproduce, we shall get a geometrical progression, until in a few months there are millions of rhabdites in the mine. To this add the probability that other miners are infected, and the amount of *materies morbi* becomes truly appalling. Probably 10 per cent. of the British Central African natives, and a certain percentage of Chinese have ankylostomes in their systems, consequently the possibilities of the infection of some of the Rand mines are not altogether negligible.

The next point to be considered is, when does a healthy person, having ankylostomes, begin to suffer from ankylostomiasis? In the first place, it is natural to suppose that the worm, fixing itself as it does on to the intestinal wall, causes the anæmia (to some extent at least), by extracting the blood from the vessels. A healthy adult, weighing 10 stones, possesses nearly eleven pounds of blood. The amount of blood which one ankylostome would remove is therefore negligible. In point of fact, in countries where ankylostomes are indigenous, it is a common experience to find many healthy inhabitants who have ankylostomes in their intestinal canal, and whose dejecta contain numberless eggs.

It is now fairly generally accepted that an otherwise healthy man will not suffer from the disease, unless and until he has harboured 500 worms for a period of six months. Considering the size of the worm, and the amount of blood in the tissues, this seems a small number, but there are certain facts which serve to explain this. In the first place, the worm is very wasteful with the blood. The red discs pass through the body of the worm almost unaltered; the worms appear only to use the plasma, or fluid part. Secondly, the irritation which the worms produce prevents the proper secretion of the intestinal juices, and, as the worms are found aggregated in the first portion and upper part of the second portion of the intestine, this has a great influence upon the digestive process; and, in consequence, the sufferer does not get the proper amount of nourishment from his food, and he will be (from this fact alone) inclined to anæmia.

The history of the parasite having now been traced, it is easier to see how the symptoms are produced. As has been said, the marked symptom of the disease is a profound anæmia, and is caused by the extraction of the blood from the system by the worms. There are several kinds of anæmia, in which the blood may show either qualitative or quantitative changes or both; but this form is a true simple anæmia, that is, it is a quantitative change, due simply to the deficiency of blood, and neither to a wrong proportion of the normal elements nor to the presence in the blood of constituents not normally present.

It would be needless to enumerate all the various and progressive conditions due to anæmia. It is only necessary to say that the whole body suffers in every part; directly, because there is not sufficient blood to enable the patient to do his ordinary work, and remotely, because, owing to lack of proper repair of the organs, they undergo degeneration, and cease to perform their function properly. Owing to the anæmia, the intestinal juices deteriorate in quality or in quantity or in both particulars. When to this is added the fact above mentioned, that the presence of the worms in the intestinal canal causes irritation and secretion of mucus instead of the proper juices, it is easy to understand the very common phenomena observed, namely, the presence of undigested food and mucus in the dejecta, wind, and ravenous, and often perverted, appetite. The whole danger of the disease arises from the anæmia, and the symptoms are nearly all the results of this anæmia.

One prominent symptom not due to this has been found in many cases, particularly in those working with or in damp soil; this is a peculiar itching of various parts of the skin, often accompanied by a rash like a nettle-rash, which, through the irritation of scratching, may become pustular. Since Looss showed that the rhabdite could gain entry into the skin, it has been shown that the irritation is due to their presence in the hair-follicles. In the Dolcoath epidemic this symptom was very prominent. An interesting fact in connection with this symptom has been brought to light by Bentley. In Assam, where ankylostomiasis is endemic, there is a skin-affection among the agriculturists, coincident with the onset of the rainy season. This is known by the natives as "panni-ghao" or "ground-itch." Bentley has shown that this is produced entirely by the rhabdite, and that it occurs in both those actually suffering from ankylostomiasis and in those who are apparently healthy; many of the latter, however, are found to harbour ankylostomes in their intestines.

Another symptom was first noticed by Delamere; he describes it as a peculiar marking of the tongue "exactly as if the patient had just wiped a penful of Stephens' blue-black ink on his tongue." This was noticed in British Guiana, and it was objected by Duprey that this marking was due to the natives chewing a certain root. As Delamere was treating all kinds of natives, all supposed to be chewing the root, it is strange that the black marking should be confined to those patients in whose dejecta he found ankylostomes. Still more curious is it that Dr. Robert Howard, of Lake Nyasa, British Central Africa, should state that he sometimes saw the black marking, and in every native so affected whose dejecta he had examined he had found ankylostomes. Daniells has found a pigmentary degeneration of the organs in non-malarial patients dying of ankylostomiasis. This points to something more than can be accounted for by mere anæmia. Daniells explains it by the supposition that the worms excrete a poisonous substance, which is absorbed from the intestines, and has a deleterious influence upon the tissues.

The disease is dangerous only when it is not diagnosed, and therefore not treated. A few ankylostomes will probably do little harm, except perhaps through the æsthetic objection that one has to harbouring parasites. But when numerous ankylostomes are tapping the blood for long periods, the changes produced may be so profound that recovery becomes impossible; many cases are on record where the patient has succumbed to ankylostomiasis, even though at the time of his death all the ankylostomes have been expelled. In a healthy man a few ankylostomes might hardly be worth removing, if

it were not that he is a source of infection, and that for a long time; the parasites may live for 4, 5, or even 8 years in the intestinal canal. As the appearance of the disease in an individual depends upon the dosage, and as no idea of the number present can be obtained until they are expelled from the body, it is surely better to err on the safe side and get rid of them.

In miners, who are more anæmic on account of their work than those working aboveground, it would be very unwise to neglect the disease, for both reasons. Firstly, because a smaller number of ankylostomes would probably cause the disease in their case, and secondly, because they would be a source of infection not only to themselves but also to their fellow-miners.

The diagnosis of the disease is simple, as is also that of the infection. The ova are very numerous in the dejecta, and under the microscope are easy to see. The prognosis is good if the disease is diagnosed early, but bad if not diagnosed. The treatment consists in expelling the worms, and reducing the anæmia by appropriate medicines.

That "prevention is better than cure" is as old a maxim as it is true. The recent epidemics at Dolcoath, at Liége, and in Westphalia, need only be mentioned to prove that it would be undesirable to have an epidemic on these fields, where labour already is somewhat scarce. The methods of prevention are probably much easier to indicate than to carry out.

Firstly, the worms should be eliminated from all those harbouring them. This seems to be quite impossible, since many on the mines may be harbouring them, and yet be in perfect health. At any rate, no person found to be suffering from ankylostomiasis should be allowed down the mine until all the ankylostomes have been expelled. This is done by giving male fern, thymol, or santonin, calomel, and quinine, keeping the patient under observation and examining the dejecta until no ova are found in them. It is here to be remarked that it frequently happens that ova disappear and reappear even though re-infection has been impossible, and this is due to the fact that the young forms are much less affected by the anthelmintic than the adult worms, and they become mature and reproduce after the exhibition of the medicine.

Secondly, the dejecta should be treated in such a manner that the ova are killed and prevented from hatching. The ordinary methods of sewage-disposal are not applicable in this disease, since the ova are neither killed nor prevented from hatching. The method which has been adopted, both in Cornwall and Westphalia, is to place all the dejecta in carbolic-acid solution, as this kills the ova easily and quickly. Whether it is possible on the Rand to do this, the writer, unfortunately, is unable to say. It seems to him, from his slight knowledge of the native, that it will be difficult to prevent the latter from voiding his dejecta wherever he happens to be at the psychological moment. Aboveground, it may be a comparatively simple matter to adjust; but the most dangerous place to get infected is, undoubtedly, the mine itself, and this will be the most difficult place to keep sterile.

Fortunately, no epidemic of this disease has appeared nearer to the Rand than Kimberley, and it may be remarked that it is time enough to think about the risk of infection when the disease has made its first appearance.

M. W. B.

THE COONEY GOLD- AND SILVER-REGION, NEW MEXICO.

The Mogollon Range. *By* W. J. Weatherby. *Mines and Minerals*, 1901, *vol. xxii., pages* 97-101, *with* 5 *illustrations in the text.*

The Cooney mining district is in that portion of the Mogollon Mountain range which lies in Socorro county, New Mexico. The formations are essentially volcanic, and the predominating rocks are andesites. The two largest veins are the King and the Queen, each over 10 miles in length and from 10 to 40 feet wide, and both have the same general north-and-south trend as the range. Both carry gold and silver, with little or no copper. The Queen is a true fissure, but the King is better described as a fissured faulted zone. Other valuable veins, a mile or more in length, lie between the King and Queen, and in some cases cut through them.

There are about 200 locations, each 1,500 by 600 feet, in the Cooney district, and nearly one-third of these have produced ore running from £12 to £30 (60 to 150 dollars) per ton. But the future great wealth of the district lies in the large bodies of £2 to £4 (10 to 20 dollars) ore.

Until recently, the milling has been exclusively performed by the pan-amalgamation or Washoe process. The best saving ever attained by this process was a short run at the Maud S. mill which produced bullion for 83 per cent. of the battery-assays. But the average saving in all the mills has been less than 60 per cent. and in some instances, for many weeks at a stretch, has been less than 50 per cent. of battery samples.

The Helen Mining Company have added Dimmick sizers and concentrators to their stamp-mill at Graham, and by the combined process of amalgamation and concentration, there is a saving of from 93 to 97 per cent. The Dimmick machines are unique, in that neither classifiers nor concentrators require any motive power, and can be made complete on the spot. The sizing and classifying is accomplished in a specially-arranged and partitioned **V** tank, 15 feet long and 10 feet high, with sloping sides and perpendicular ends. The sands are first separated from the slimes, and the latter gathered into a closer consistency of pulp and water by submersion and suction, without the least loss of values, the excess water removed being quite clear and classification being made up to 120 meshes or finer. Each size falls into a separate apartment, passes to its own launder and thence to its proper concentrating-table. By ordinary methods of hydraulic sizing, water is continually added, so that, owing to excess of water, satisfactory concentration can seldom be attained. The Dimmick table is without motion, and consists of an even surface covered with canvas and thickly studded with nails. The table is given a pitch depending on the coarseness of the pulp, the nails act as riffles, and when the table becomes loaded with concentrates, the valuable product is removed in a minute by means of a hose carrying water under pressure. The same company have installed a pipe-line over 6,000 feet long, up Whitewater Creek, at a cost of about £20,000 (nearly 100,000 dollars). The mill is thus run a large portion of the year by water-power and electricity conveyed to the mines for the operation of an air-compressor plant and electric hoist.

At the Last Chance mines, three standard concentrators have been erected. The table is of the bump type, freely suspended from three points, little power is required to drive it, whilst the force of the bump and also the degree of inclination can be regulated with the utmost precision. The surface is covered with linoleum, the table weighs about 1 ton, occupies a floor-space of 11 feet by 15 feet, handles 15 to 20 tons of ore per day,

and uses only 3½ gallons of water per minute. The top, or feed, end of the table is much narrower than the discharge end. Standing at the lower end, one sees a series of small wooden riffles, parallel to the base, extending the whole length of the table, but only covering two-thirds of it from right to left, the remaining one-third on the left being smooth linoleum. The riffles vary in height from about ½ inch on the right to about ⅛ inch on the left, where they give way to the clear unriffled or final cleaning space. The bump tends to throw the metallics completely to the left wall of the table but as they pass from the riffled portion to the unriffled space, they meet the opposing force of the wash-water—the resultant of the two forces causes them to travel down the smooth surface, continually subjected to the cleaning action of the water until they reach the receptacles at the discharge end. The heavier the mineral, the farther to the left on the clear space is it thrown. At the Last Chance mill, towards the left wall of the table, can be seen a downward moving yellow line of gold; then to the right after a blank space, the parallel line of bluish-black silver sulphides, whose specific gravity is about 7; then a line of yellow gold-bearing pyrites whose specific gravity is 5·2; and finally the whitish wild iron-pyrites, or marcasite, having a specific gravity of 4·7.* Concentrates and tailings alike are thus discharged over the base end of the table, the former on the smooth and the latter on the riffled side. It is proposed to treat middlings of any appreciable value by the cyanide process. X. Y. Z.

THE SILVER-MINE OF TEXAS.

The Silver-mine of Texas. *By* Henry M. Adkinson. *The Engineering and Mining Journal* [*New York*], 1902, *vol. lxxiv., pages* 150-151, *with* 2 *illustrations in the text.*

The silver-production of Texas is entirely the output of the Presidio mine, near Shafter, Presidio county.

The Presidio mine was opened up about eighteen years ago, and has been a constant and notable producer ever since. A bulletin issued in January, 1902, by the Texas Geological Survey stated that during the past fourteen years the mine has produced £1,200,000 (6,000,000 dollars) worth of silver, whilst the *Mineral Industry*, from 1893 to 1900, gives £60,000 (300,000 dollars) as the average annual production for those eight years.

The region, around Shafter, is composed of a dolomitic limestone, which has been tilted from its original position by the intrusion of the igneous mass forming the Chinatti mountains. In the vicinity of Shafter, these mountains lie generally east and west, and the mine lies on the southern side of the range. The southerly dip of the limestone-strata varies from 20 to 45 degrees. Accompanying the Chinatti uplift, dykes of a porphyritic-felspar character were intruded into the limestone without penetrating to the surface. The dykes seem to influence the location of the ore-bodies, in that the greater portion of the ore has been found in their vicinity, though not always in contact. In general, the ore of the Shafter district is an argentiferous galena, with surface-indications of copper, although none of the latter is mined. In the Presidio mine, however, the ore is a free-milling silver chloride, carrying traces of gold, with only occasional pockets

* *Trans. Inst. M.E.*, 1902, vol. xxiii., page 179.

of high-grade lead-ore. The line of demarcation between the silver-chloride and the argentiferous galena ores seems to lie about ½ mile west of the Presidio mine.

The ore in the Presidio mine occurs in pockets and also as impregnations of certain limestone-strata. Some of the pockets, stoped out, are 50 to 60 feet high and hundreds of feet square. The impregnated strata are being extensively worked at present, and these follow the dip of the country.

X. Y. Z.

COAL-MINING IN NEW ZEALAND.

Report of the Royal Commission appointed to inquire and report on the Working of the Coal-mines of New Zealand, 1901, 33 *pages*, *Wellington, New Zealand.*

The Commission was appointed on November 22nd, 1900, and its powers were extended on April 3rd, 1901.

The Commission recommend the appointment of a chief inspector of coal-mines, and that each district-inspector shall report monthly to the chief inspector. In case of difficulty between the inspectors and the mine-owners, it is suggested that the chief inspector shall be furnished with special powers to act promptly and effectively, in order to remedy what may be amiss. Under the present system, the inspectors report annually to the minister of mines, and this has led to matters being allowed to stand over which ought to have been dealt with at once. The inspection-districts also, in the Commissioners' opinion, are too large; additional inspectors should be appointed, the mines should be inspected more frequently, and the forfeiture-clauses enforced where mines are left unworked or neglected for considerable periods.

The Commission further urge that surveys of coal-bearing lands, and of lands suspected to be coal-bearing, should be thoroughly taken in hand, and a determined effort made to ascertain how far the colony can rely upon a coal-supply for the next generation. Immediate efforts should be made to ascertain where coal-bearing areas are situated on crown lands, and they recommend that such lands should not be sold. It is pointed out that, whilst under certain conditions, freehold lands may be resumed for coal-mining purposes, yet the compensation to be paid to the owner generally prevents such resumption. The Commission strongly urge that all coal-areas not now worked should be reserved to the state. The establishment of coal-mines owned and actually worked by the state was much pressed upon the Commission, but the question involves so many political considerations that it can only be dealt with by legislation. But in the meantime, the acquisition by individuals of areas which may be required by the people generally should be prevented.

The Commissioners were much pressed to recommend a differential haulage-rate on the various classes of coal carried by rail. The question is, however, one for railway-administrators, and the Commission commend the subject to the serious consideration of those authorities.

Much evidence was also taken on the subject of the cost of coal to the consumer, as compared with the cost of production. The difference consists of the cost of distribution. A striking example of this latter cost is quoted. The Westport Company's coal, which is produced at 7s. 10d. per ton in the railway-trucks at Waimangaroa is retailed in Wellington at 35s. per ton nett. Also Mokau coal, produced at the mine at 8s. 6d., is sold retail in

New Plymouth at 34s. per ton. The same proportion practically exists throughout the colony. The Commissioners believe that if the State, which now buys a large quantity of coal at a moderate price, would sell such coal at a fair price to consumers, the grievance now complained of would vanish, and the result would be that, while the state would fix the fair retail-price of coal, the present dealers would sell at the same price and would not be injured.

Nearly all the coal worked is brown, lignitic or pitch. The method of working in New Zealand is usually bord-and-pillar; very little longwall is seen, and several of the mines are open working. A few mines are ventilated by fan, one or two by furnace, and several by the exhaust-steam from pumps, but the majority of the mines are ventilated by natural means alone. In 1900, the men ordinarily employed above-ground numbered 617, and below-ground 1,843, the total number being 2,460. The output for the year was 1,093,990 tons, of which 898,286 tons were coal, and 195,704 tons were slack.

The detailed accounts, given in the body of the Report, of the Commissioners' visits to various centres are extremely interesting, and in some few instances, distinctly amusing. X. Y. Z.

THAWING AURIFEROUS GRAVELS BY STEAM.

Mining on the Klondike. By A. J. Bowie. *Mines and Minerals*, 1901, *vol. xxi. pages* 529-534, *with* 5 *illustrations in the text.*

The writer describes the "firing" methods of sinking and drifting in the frozen gravels of the Klondike region. In 1898, however, it is stated that experiments began to be made of thawing by steam, and though the apparatus first used was very crude, the experiments gave very encouraging results. During the winter of 1899-1900, as the plants were improved, it was demonstrated that the method of thawing by steam possessed very great advantages over the method of firing previously employed.*

A thawing plant should consist of a boiler, pipes, set of points, and a hoisting-engine with drums complete. Each point requires at least 2 horsepower, and a plant with 10 points should have a 30 horsepower boiler. The boiler should supply dry steam. Locomotive-boilers have given the best results, but any good boiler will do the work. In view of the rigorous climate, special protection should be given to the main steam-pipe. The size of the main feed-pipe is regulated by the number of points; 10 points demand a pipe 1 inch in diameter. In the drifts, the steam-pipe is fitted with unions at convenient distances for disconnecting and drainage-purposes. The feed-pipe is carried down the shaft, and along the drift to the breast where a T is placed, and a cross-head run the full length of the face to be thawed. The cross-head is fitted with valves, 3 feet apart, each point having its own valve. A length, 6 feet, of ½ inch steam-hose connects the point with the valve.

The point consists of an iron pipe, ¾ inch in diameter, 3½ feet long, drawn to a point at one end with a discharge ⅛ inch in diameter; having on the other end a heavy steel head, 1½ inches in diameter, 4 inches long, welded or screwed on; and in its side is placed a ⅜ inch nipple connecting with the hose. For draining the point each morning, a radiator-valve with a

* *Trans. Inst. M.E.*, 1900, vol. xix., page 564.

union attached is used. The hose is fastened to the nipple with baling wire, the nipple being first heated and inserted hot into the hose. When all the pipes have been connected, steam is turned on.

In starting the points, they are held against the face one by one and worked into it as the ground thaws, for about 1½ feet, being driven with a wooden mall for the remainder of their lengths. The entering of the point sufficiently far to enable it to hold its own weight requires about 5 minutes, but it takes quite 3 hours to work 10 points in for their full lengths. The points being in, a full head of steam is turned on, and they are allowed to remain in the breast till 5.30 a.m. on the following day, supposing the pointman to have begun his shift at 6 p.m. on the previous day. When the points are withdrawn, the pipes are disconnected, and the water pumped from the sump. An examination of the ground will show that the breast has been thoroughly thawed, 6 feet high and 8 feet deep. In contradistinction to the firing system, the thawed mass does not (in order to avoid its rapid re-freezing) require to be removed at once; the cobbles and stones in the gravel retain the heat, and do efficient thawing even 24 hours later.

The great advantages of thawing the gravel by steam, as compared with the system of firing, are:—(1) It can be used at all seasons; (2) there is greater security to life; (3) there is no loss of time; (4) dead-work is reduced to a minimum; (5) waste is more economically handled; (6) the control over the heat is absolute; (7) fuel is economized; (8) the gravel is better thawed, its removal is more economical and expeditious, and with the use of a small hoist, there is additional economy of labour with an increased output. As rough examples of comparative costs of firing and steaming, the writer states that in 1899, under the ordinary firing system, the cost per cubic yard of gravel extracted from a mine on Dominion Creek was from 17s 6d. to £1 4s. 6d. (4·2 to 5·91 dollars); and in 1900, at a mine on Sulphur Creek, where the newer method of thawing by steam was employed, the cost was 7s. (1·69 dollars) per cubic yard. X. Y. Z.

WORKING DEEP COAL-SEAMS.

A New Method for Working Deep Coal-beds. *By* H. M. Chance. *Transactions of the American Institute of Mining Engineers*, 1900, *vol. xxx.*, *pages* 285-290, *and* 1112-1115, *with* 1 *illustration in the text, and* 1 *plate.*

The writer emphasizes the difficulties of ventilating the ever-extending workings of deep mines so as to carry off the explosive gas, which is generally found to increase in quantity with the depth. He points out that what is considered an excellent roof, in a seam of moderate depth, becomes a bad one, unable to stand the pressure of a great thickness of overlying strata. He considers the greater danger of "squeeze," the general crushing-down of the pillars of coal left to support the roof in deep seams. After enumerating the many sources of increased difficulties and the consequent advance in the cost of working by the ordinary methods, he describes a new system of driving out and working deep coal-seams, showing various adaptations to meet the conditions of gradient, soft coal, water, etc., and he claims that it possesses many advantages, without increasing the cost of production. The paper is illustrated by a plan, without the aid of which a detailed description of the methods suggested would become very involved. A. W. G.

GOLD-DREDGING IN THE UNITED STATES.

(1) *Gold-dredging in North Georgia.* *By* HENRY V. MAXWELL. *The Engineering and Mining Journal* [*New York*], 1901, *vol. lxxii., page* 564, *with* 2 *illustrations in the text.*

Recent experience, on the Chestatee and Yahoola rivers, demonstrates that owing to the existence of submerged timber in the placers along the banks and the jagged outcrops of country-rock in the present river-beds, chain-dredges cannot be successfully operated and dipper-dredges only are employed. Two styles of these are employed, and they differ materially only in displacement and capacity. The dippers are of ¾ yard and 1 yard capacity, and the speed is about one dipperful per minute. In the one, an auxiliary sluice-boat is constructed, whilst in the other, two sluices (one on each side of the main boat) are built. In the first, all material is dumped into an iron-bottomed box, 10 feet square, into which 2,000 gallons of water are forced by a centrifugal pump placed under the deck, and operated by steam conveyed through indiarubber-hose from boilers on the main boat. The stream carries the sand and gravel into two sluices, 60 by 3 feet, leading from the box. These have a grade of ½ inch per foot, whilst racks are placed in the bottom to catch the gold. The heavy rock not moved by the water is dumped by hand over the side of the sluice-boat. Thus the refuse is piled directly behind the sluices, and upon the side farthest from the main boat, so that the boats can be dropped down stream to another trough without re-handling the material.

In the case of the second style of boat, similar methods obtain, except that by dumping into sluices at both sides, the refuse often has to be moved a second time. Conditions vary, however, and both methods are successfully employed. An experiment with a suction-pump is soon to be made, as well as an effort to save the black sand, which is abundant and runs from £4 to £21 (20 to 100 dollars) per ton. Recently one boat, finding it impossible to operate, owing to the excessive quantity of submerged timber, suspended dredging, and employed a lift operated with water from the boat. By this method some high values were obtained.

(2) *Dredging for Fine Gold in Idaho.* *By* ROBERT BELL. *The Engineering and Mining Journal* [*New York*], 1902, *vol. lxxiii., pages* 241-242, *with* 2 *illustrations in the text.*

In spite of a general impression to the contrary, the successful recovery of fine gold from the Snake-river placer-beds has been an accomplished fact for many years. The adaptation of the floating dredge to the conditions here encountered seems to have opened up an extensive field for profitable gold-mining.

The Sweetser-Burroughs dredge-boat was built in 1894 at a point 30 miles south-west of Minidoka. This suction-dredge, started with a 6 inches nozzle, which was changed in 1895 to one of 10 inches, has been in constant and successful operation during the open season ever since. The hull of this boat is 30 by 90 feet, drawing 3 feet of water, and the dredge has an actual daily capacity of 2,500 cubic yards. Motive power is supplied by a 125 horsepower vertical compound-condensing marine engine, receiving steam from two return-tube boilers. The gravel is discharged into a stationary sluice, 12 feet long, set nearly horizontal, in order to check the velocity of the stream of gravel before it passes to the adjoining two lengths of shaking sluice, each 17½ feet long and inclined at 1 in 24. The sluices,

5 feet wide, are arranged to shake endways with a 3 inches stroke. The sluice-bottoms are made of perforated steel-plates, No. 10 gauge, $\frac{1}{8}$ inch holes, spaced $\frac{3}{8}$ inch apart. The coarse material passes to an indiarubber belt-conveyor, which deposits it sufficiently astern to prevent it from interfering with the operation of the boat.

The fine material, including the gold, after passing through the shaking-screens, is discharged into a distributing-box, which feeds it evenly to a set of 16 inclined burlap-tables, with an aggregate surface-area of 1,000 square feet, set at right angles to the sluices. The burlaps are taken up at intervals of 6 or 8 hours, and washed in a wooden tank, from which the accumulated gold and black-sand concentrates are elevated automatically to the amalgamating-room; quicksilver is here added, and the gold readily separates by a simple barrel-process of amalgamation, after which the amalgam is retorted, melted and run into bars, and shipped to Boise, where it realizes £4 (19 dollars 40 cents) per ounce.

The cost of handling gravel at this plant, including all charges, is $2\frac{1}{4}$d. ($4\frac{1}{2}$ cents) per cubic yard, and affords a handsome margin of profit. A new dredge-boat, built in 1899, is of the chain elevator-bucket type, the digging buckets are of 5 cubic feet capacity, and the boat has shown an actual working capacity of 2,000 cubic yards per day over a period of 20 consecutive months. The gold-saving arrangement is about the same as on the first boat described. Both plants work continuously throughout the 24 hours, both are lighted by electricity, and both are connected with the railway-station at Minidoka, and with each other, by telephone.

X. Y. Z.

THE GOTHAN STRATAMETER.

(1) *Der "Stratameter" von Hermann Gothan in Gross-Lichterfelde. By* H. Thumann. *Glückauf*, 1902, *vol. xxxviii., pages* 55-57, *with* 1 *illustration in the text.*

(2) *Der Gothan'sche "Stratameter": Apparat zur Ermittelung des Streichens und Einfallens der Gebirgsschichten in Bohrlöchern und der Abweichung der letzteren von der Lothlinie. By* H. Thumann. *Zeitschrift für praktische Geologie*, 1901, *vol. ix., pages* 389-391.

This instrument, for measuring the dip of strata in deep bore-holes, consists of a train of clockwork which at a given moment, arrests a compass mounted on the upper surface, and simultaneously releases a plummet situated below. The whole is mounted on a brass cylinder, 14 inches deep and 2 inches in diameter, so that the clockwork and compass are visible at the top and the plummet and marking disc at the bottom. At the moment of arresting the needle three equidistant teeth on the compass-rim press up into an indiarubber disc and restrain any further movement of the needle. The brass plummet carries a properly centred steel point, which on coming into contact with the recording disc, of tinfoil or paper, makes an indelible mark upon it; and as the plummet point then retreats into the body of the plummet, there is no risk of the mark being obliterated. The brass rim round the disc is inscribed with the four points of the compass.

For use, the stratameter is enclosed in a double case of delta-metal which is attached to the boring rods, and is closed by a conical plug which seals it hermetically. This case is 40 inches long, and to it are attached the

core-barrel and boring crown. Before breaking off the core, work is stopped for 20 minutes, to allow time for the needle and plummet to attain a state of repose (the plummet-barrel is filled with oil to restrain oscillation). On raising the tool, and removing the head-piece of the stratameter, the north-and-south position of the arrested compass-needle is marked or painted on the core itself, by the aid of a zinc cylinder. The core is next taken out and placed on a board, so that the north-and-south marks correspond with a line on the latter; the plummet-barrel is placed on the core, and by means of the freed compass-needle and the plummet—which must coincide with the mark made on the disc while in the bore-hole—the core is adjusted to the position which it occupied in the hole, whereupon the dip of the strata can be measured. By the aid of the plummet-mark any deviation of the bore-hole from the vertical can be ascertained and measured, which is an important feature when a series of parallel holes for shaft-sinking by the congelation-process is in question.

The author dwells on the advantages of this appliance as compared with any other system. He cites a case in the north of France, where a bore-hole had been put down to a depth of 1,245 feet and then abandoned. A German firm undertook to continue the bore-hole, and met with great difficulties on account of serious deviations from the vertical; these had arisen, because the crown of a borer which had stuck in the strata had been passed by. The disputes which ensued thereupon were satisfactorily settled by means of the Gothan stratameter. L. L. B. and C. S.

FLOTTMANN PNEUMATIC ROCK-DRILL.

Die Flottmannsche Gesteinsbohrmaschine. By — Limberg. *Glückauf*, 1902, *vol. xxxviii., pages* 217-219, *with* 1 *illustration in the text and* 1 *plate.*

The Flottmann drill consists of a cast-iron cylinder enclosing a Siemens-Martin steel piston with a long bearing-surface, and guided by the piston-rod or main spindle moving in a long bearing packed with a broad leather collar in the front cylinder. The auxiliary valve is pivoted, and swings to and fro under the influence of shoulder-pieces on the reciprocating piston, thus automatically setting the piston of the main-valve for the admission of compressed air to each end of the cylinder in turn. This arrangement is designed to reduce the wear caused by the high friction in the ordinary shell-valve.

The twist spindle is rifled, mounted on a ratchet-wheel in the back cylinder-head, and is connected with the hollow main spindle by means of a nut. During the return of the drill-spindle, the rifled spindle is held fast by pawls, and thus imparts the necessary twist to the drill-point, but during the forward stroke the pawls release the rifled spindle, and enable a straight blow to be delivered on the rock. By an arrangement of channels in the rifled spindle, nut and piston, the full working area of the latter is utilized in the forward stroke. A slight cushioning effect is produced at each end of the cylinder by a special disposition of the air-ports, to prevent the injurious impact of the piston on the cylinder-heads. C. S.

DEVELOPMENT OF ELECTRICALLY-DRIVEN ROCK-BORING MACHINES.

Ueber die Entwicklung der Gesteinsdrehbohrmaschinen mit elektrischem Antriebe. *By* C. SCHRAML. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1901, *col. xlix.*, *pages* 263-266, *and* 1 *plate.*

The Siemens-and-Halske electrically-driven rock-boring machine was introduced into Austrian salt-mines about 1894, and many hauling, boring, and ventilating engines are now worked by the same power. Improvements in boring-machines, on the lines of the best hand-drills, and combining the advantages of both types, are much needed. The first Siemens-and-Halske machine, already described,* had a differential thrust, a motor-box, and a flexible shaft, and this inconvenient three-fold division of the parts was avoided in the next, which was more compact. Experiments have been suggested or made on three types of drills, the Siemens-and-Halske, the Union and the Bornet, to determine which is the best.

The experiments on the Siemens-and-Halske and Union machines were made in 1900, and were comprised in a 6 hours' shift for two men. This shift was too short, 30 per cent. of the time being employed in going to and fro, 32 per cent. in removing the material, and 38 per cent. in the actual work of boring. In four experiments made with the Siemens-and-Halske machine, 17 holes were bored; in three with the Union 19 holes were bored. For every $3\frac{1}{2}$ feet bored in rock of medium thickness, the total average time required to erect the machine was with the Siemens-and-Halske, 18 minutes; with the Union, 11 minutes; and for actual boring 13·7 minutes, and 6·8 minutes respectively. The great speed of the Union machine, due to the absence of a brake, was not an advantage, and the Siemens-and-Halske machine was able to pierce hard anhydrite, which the other drill could not touch. Holes were also drilled in the roof, floor and sides of the mines; the roof-holes took 12 per cent. less time for the same depth, because the bore-dust fell out easily, and did not impede the action. The number of drills used in the same kind of rock was noted for a month, and was 12 per cent. more with the Siemens-and-Halske machine. The wear of the drill depends on the nature of the rock, but neither machine could be worked continuously in hard rock, both becoming overheated in 34 and 37 minutes respectively. E. M. D.

MECHANICAL COAL-CUTTING.

Organisation d'un Service de Havage Mécanique dans une Mine de Houille. *By* A. DE GENNES. *Comptes-rendus mensuels des Réunions de la Société de l'Industrie Minérale*, 1903, *pages* 31-40.

Although many attempts at working coal by mechanical means have been made in France, especially during the past two years, not one has yet entered the stage of application on a large scale to a whole colliery.

The causes of this slight success in France are of two orders, material and moral. With respect to the first, the deposits are less regular, as regards thickness and dip, than those in the United States; and the roofs are generally bad, so as to require much timbering, which interferes with the working of the machine. This accounts for the restricted use of the chain coal-cutter; but it is not sufficient to prevent the use of pick-machines. Wherever coal requires the use of the pick, it can be better worked

* *Trans. Inst. M.E.*, 1902, vol. xxiii., page 719.

by a machine than by manual labour; and this truth will in a few years become generally recognized, the miner's two-pointed pick being superseded by the coal-cutter.

The three greatest natural obstacles to the use of the pick-machine are a bad roof (requiring much timber), high dip and slight thickness of seam. The difficulty as to timbering, though great, is not insurmountable, for the pick-machine can work in the midst of timbers only $3\frac{1}{4}$ feet (1 metre) apart in every direction; and in a Pas-de-Calais colliery, with hard coal and a dip of 20 degrees, a machine has worked at the rate of 13 feet (4 metres) per hour, including the placing and shifting of the platform, while making a cut nearly 5 feet (1·5 metre) deep.

As regards the difficulty of dip, French engineers have done even better than American, for at two collieries in the south of France seams dipping 40 and even 45 degrees have been worked by a machine fastened to a timber by a chain, with or without pulley and counterweight, while in the United States, the limit is 14 or 15 degrees.

The third difficulty is insurmountable because, when the thickness of the seam is less than $3\frac{1}{4}$ feet (1 metre) the position of the workman is too difficult; and, although an experienced miner can work in a seam of 2 feet 8 inches (80 centimetres) and even less, such seams are certainly not favourable for a new departure.

The conditions depending on the human element are more serious, because every one in the colliery, from the general manager to the working miner, has to be considered. The former is lured on by the prospect of greater output without increase in the number of hands; and then each official has his own opinion on the matter, while the observation of an eminent chief-engineer that "for new tools fresh methods are required" is often ignored. To his great surprise, the author has found that the least resistance is offered by the working miner; but, after all, what the hewer has to say is of no great consequence, because it is not he who will have to work the machine, although his experience in timbering will find him occupation.

As a solution of the problem, the machine should by preference be entrusted to young, active and skilful men, as they are more suitable for this work than those possessing great physical power. The time lost in becoming accustomed to a machine is largely compensated later on; and the fatigue experienced at first is surmounted after a little practice. The man who is to take charge of a machine should begin as second hand.

There are only three valid excuses for slight production—want of picks, want of pressure, and the necessity of waiting for a place to be cleared in which the machine can work; and these three requirements should be looked after by the overman.

Any large plant of mechanical coal-cutters, should be placed under the charge of a skilled miner, or better still a mechanic accustomed to underground work, taking his orders directly from the underground manager, and pecuniarily interested in his work. He should also have been accustomed to the actual working of the machine; and, if the mine be not very large, he might too have charge of the compressed-air pipes.

Independently of the supervision exercised by the under-manager, it is advisable, in a large colliery, to train a young mining and mechanical engineer in the use of coal-cutting machinery, especially at the commencement of its use; and, while it is important to unify methods, he will with advantage keep the manager or general manager informed as to the progress of the work. J. W. P.

EXPERIMENTS WITH PICK COAL-CUTTING MACHINES.

Versuche mit stossenden Schrämmaschinen. By BRANDI. *Glückauf*, 1903, *vol. xxxix., pages* 628-631.

The writer describes experiments made:— (1) To ascertain the amount of air and time consumed by the machine under as normal conditions as possible, in the case both of new machines and of those which had already been used and of different makes and sizes; and (2) to test a number of cutters.

The experiments were carried out in four galleries in two coal-seams, varying from 22 inches to 36 inches in thickness, and one contained a slate-band, 2 inches thick. The holing was made with the striking as well as with the swinging movement, in the coal as well as in the slate-band. A skilled workman managed the machine, with an assistant. The necessary volume of compressed air was stored in a cast-iron boiler (with a capacity of 300 cubic feet), it was connected with the principal supply of compressed air, and fitted with a spring pressure-gauge. The machine was worked with the air contained in the boiler, till its pressure had fallen from 4 to 4½ atmospheres to 2·8 to 3 atmospheres. If the air in the boiler at the beginning of an experiment had a pressure, a, it received $(a+1)$ times the boiler-contents of air at no pressure; if the pressure were b atmospheres at the end of the cutting, it received $(b+1)$ times the boiler-contents. It was therefore only necessary to record the difference of pressure in the boiler before and after each period of cutting. The sum of these differences, multiplied by the volume of the boiler, showed the amount of air consumed by the machine during the entire period of cutting.

Seven machines were received from various manufacturers:—Messrs. Frölich and Klöpfel, Unterbarmen; Mr. Korfmann, Witten; Mr. Flottmann, Bochum; and Messrs. Bechem and Keetmann (Eisenbeis), Duisburg.

Only successful experiments have been tabulated, the results according to the different kinds of cutters used, being as follows:—(1) Common swallow-tailed chisels; (2) cross chisels, and (3) those with three radiating cutters. These did not prove unexceptionable. In all three, the length of the stroke varied, in consequence of being moved to a new place. If a long chisel strikes into a short groove the chisel often becomes tightly jammed. This defect shows more or less, accordingly as the coal is tough or brittle. The cutter with five long points (Messrs. Bechem and Keetmann No. 4) and that with five interchangeable blades (Messrs. Frölich and Klöpfel No. 5) avoids this defect. The first-named cutter, in consequence of its smaller diameter, shewed somewhat better results. When both are of the same dimensions, they will be equal in value and are both to be recommended.

The experiments recorded in Table I. show, comparatively speaking, an extraordinarily small consumption of air by all the machines. The experiments are arranged according to the depth of the holing. Even the seemingly greater differences, arising either from varying dimensions, difference of length of time in use, or from the kind of cutter employed, become insignificant when one calculates the cost. Under favourable circumstances 35 cubic feet of compressed air at a pressure of 4 atmospheres costs, on the spot, 0·15d. One square metre was cut, at the normal depth of 5 feet 7 inches with a minimum of 880 cubic feet of air and a maximum of 1,500 cubic feet, or 176 and 300 cubic feet respectively at a pressure of 4 atmospheres. One square metre, accordingly, costs 0·75d. to 1·29d. for air consumed. It is immaterial whether 1 square metre of under-cutting costs 0·75d. or 1·29d. More important is the difference

in the length of time occupied, as the cost of labour per hour for the two necessary workmen at 2s. 7d. per shift is 1s. 7d. (1·60 marks). According to Table I., the quickest working machine under-cut 1 square metre to a depth of 5 feet 7 inches in 21 minutes, the longest in 34 minutes working all the time, which shows a cost of 6·5d. or 10·2d., a difference of 3·7d., or six times as much as the difference in expenditure on the air consumed for holing 1 square metre. The amount of air consumed need not be taken into consideration; but on the other hand we must attach importance to the speed with which the under-cutting is made.

TABLE I.—RESULTS OF EXPERIMENTS FOR UNDER-CUTTING 1 SQUARE METRE, ARRANGED ACCORDING TO THE AMOUNT OF TIME OCCUPIED.

Series.	Machine.	Machine. New or already Used.	Machine. Diameter of Piston.	Machine. Stroke.	No. of Cutter.	Cut.	1 Square Metre Undercut in Minutes.	1 Square Metre Undercut with Air.
	Depth of cut, 1 foot 8 inches (0·5 metre)		Inches.	Inches				Cubic feet.
A	Flottmann	New	2·76	7·28	5	Swinging outward	18·0	650
	Eisenbeis	Used	2·76	8·07	4	Swinging outward	19·6	950
	,,	Used	2·76	8·07	4	Swinging inward	24·0	1,380
	Frölich and Klopfel	New	2·95	7·87	5	Striking	26·4	980
	Depth of cut, 3 feet 3 inches (1 metre).							
B	Frölich and Klopfel	New	2·95	7·87	5	Striking	18·0	780
	Flottmann	New	2·76	7·28	4	Striking	20·9	810
	Korfmann	Used	2·76	7·87	4	Striking in slate-band	21·0	880
	Eisenbeis	Used	2·76	8·07	4	Striking	21·0	1,100
	,,	Used	2·76	8·07	4	Swinging outward	21·0	1,340
	Flottmann	New	2·76	7·28	5	Swinging outward	22·7	800
	Korfmann	Used	2·76	7·87	4	Striking in slate-band	25·0	990
	Eisenbeis	Used	2·76	8·07	4	Striking	25·0	1,410
	,,	Used	2·76	8·07	4	Striking	26·5	1,590
	,,	Used	2·76	8·07	4	Striking in slate-band	28·6	1,150
	Frölich and Klopfel	New	2·95	7·87	5	Striking	32·0	1,270
	Depth of cut, 4 feet 11 inches (1·5 metres).							
C	Korfmann	Used	2·76	7·87	4	Swinging outward	19·0	850
	Frölich and Klopfel	New	2·95	7·87	5	Striking	18·4	810
	Korfmann	Used	2·76	7·87	4	Striking	22·0	920
	Flottmann	New	2·76	7·28	4	Striking	22·2	900
	,,	New	2·76	7·28	5	Swinging outward	23·0	880
	Frölich and Klopfel	New	2·95	7·87	5	Striking	27·0	1,200
	Eisenbeis	Used	2·76	8·07	4	Striking in shale-band	32·0	1,340
	,,	New	2·76	8·07	4	Swinging inward	34·0	1,980
	Depth of cut, 5 feet 7 inches (1·7 metres)							
D	Eisenbeis	Used	2·76	8·07	4	Striking	21·0	1,100
	Frölich and Klopfel	New	2·95	7·87	5	Striking	21·2	890
	Flottmann	New	2·76	7·28	4	Striking	23·5	940
	Eisenbeis	Used	2·76	8·07	4	Striking	26·0	1,480
	Frölich and Klopfel	New	2·95	7·87	5	Striking	29·0	1,290
	Eisenbeis	Used	2·76	8·07	4	Striking in shale-band	34·3	1,530
	Depth of cut, 6 feet 7 inches (2·0 meters).							
E	Frölich and Klopfel	New	2·95	7·87	5	Striking	24·0	740
	Eisenbeis	Used	2·76	8·07	4	Striking	31·0	1,240
	Frölich and Klopfel	New	2·95	7·87	5	Striking	34·0	1,020

One should therefore choose the largest and quickest-cutting machines possible, and they should be so well built that one need reckon on no loss of time through breakdowns. These conclusions have been confirmed by many experiments, which, in consequence of the imperfect working of the machine or other hindrances, were only carried out at considerable expenditure both of time and money, and were therefore not included in the table.

It cannot be ignored that small and light machines have the advantage that they can be worked by only one man, but this only refers to the time of setting up and taking down of the machine; in places where there are more workmen it is insignificant. A light weight is not unimportant in the case of rising seams.

From Table I., the average time occupied in cutting 1 square metre in all experiments is shown to be as follows:—19·7 minutes, for a depth of under-cutting of 1 foot 8 inches (0·5 metre); 22·2 minutes, 3 feet 3 inches (1·0 metre); 25 minutes, 4 feet 11 inches (1·5 metres); 27 minutes, 5 feet 7 inches (1·7 metres); and 30 minutes, 6 feet 7 inches (2·0 metres).

These figures show the increase of time required for the same area of under-cutting at an increased depth of cutting, and establish the principle that the cutters should be made as broad as possible, in shape like the segment of a circle. A. W.

THE USE OF EXPLOSIVES.

Recherches sur l'Emploi des Explosifs dans les Mines. By H. Schmerber. *Comptes-rendus mensuels des Réunions de la Société de l'Industrie Minérale*, 1903, *pages* 26-28.

The influence of an explosive's sluggishness on its economical effect has formed the subject of long investigations, which have established almost conclusively that, the more sluggish an explosive, the greater will be the difficulty attending its detonation, especially when freely exposed to the air, and also that the more restricted the space in which the charge is fired, the greater will be the chance of detonation of a sluggish explosive. Deficient tamping and too large charges must be avoided; and the best guide to the rational use of an explosive is thorough knowledge of its properties, added to practical experience.

The more sluggish an explosive, the greater difficulty will there be in transmitting the detonation, and also the greater necessity for a good detonator, in order to avoid miss-fires and incomplete detonations. There is now too great a tendency to employ fulminating mixtures, instead of pure fulminate; but this is false economy, because such mixtures deteriorate rapidly, and detonators made with them give many miss-fires, so that the quality of the detonators should be ascertained by frequent tests. The best method is simply to fire the detonator on a sheet of lead in the open air, the quality of the detonator being revealed by examination of this sheet far more correctly than by the Trauzl lead-block.*

In rocks of medium hardness and hard or semi-hard coals it has been the practice to use drill-bits of ample diameter, so as to permit explosives of even slight density to exert their power under good conditions. In hard rocks, however, where very strong gelatine-dynamite is used, there has been a tendency to reduce the diameter of the shot-holes, on economical grounds; but such a practice must be avoided in the case of safety-explosives, as numerous experiments have proved that, if drilling the hole costs a little more, the economical effect of the explosive is practically the same.

J. W. P.

* *Trans. Inst. M.E.*, 1901, vol. xxi., page 442.

COUPLING OF BLASTING-CHARGES IN ELECTRICAL SHOT-FIRING.

Die Schaltung der Sprengschüsse bei elektrischer Zündung. By — Heise. *Glückauf*, 1902, *vol. xxxviii., pages* 325-329, *with* 4 *illustrations in the text.*

When several shots are to be fired simultaneously, the coupling can be effected in three different ways, namely:—In series, parallel or by groups. Primarily, the choice between these systems is determined by the relative resistances in the electric machine or battery and the igniters. The general rule is that, when the internal resistance in the generator is very high in relation to that of the igniters, coupling in series is preferable; in the converse eventuality, parallel coupling; whilst, where the conditions are intermediate between these two extremes, grouping may be selected. Other considerations, however, intervene, inasmuch as the current in the generators usually employed for shot-firing does not attain its full intensity at once; and, furthermore, there is always some inequality in the resistance of the individual spark- and glow-igniters. The generating machine furnishes a current of very high tension, combined with a great internal resistance, so that when spark-igniters are used, the differences in their internal resistance are relatively insignificant when coupled in series, the spark being sufficiently powerful to fire the whole at once; whereas, in the case of coupling in parallel, the divided current is weakened, and the danger arises of nearly all the sparks passing through the igniter exhibiting the lowest resistance.

With glow-igniters, the conditions are different, because these can be sorted so as to obtain an approximately uniform resistance in a set, but there is always the risk of those with the highest resistance coming first into action and interrupting the circuit. Hence, in this case, parallel coupling is nearly always advisable; series coupling being reserved for occasions where the generator is capable of instantaneously furnishing a specially powerful current, or of being automatically connected when the full strength is attained. With parallel coupling, the irregularities of internal resistance are compensated to a large extent by the subdivision of the current; and, though the shots may not all be fired with absolute unanimity, the intervals are so small as to be negligible, provided, of course, that the resistances are approximately uniform. When series coupling is employed with glow-igniters it is advisable to employ a somewhat stronger current than is theoretically requisite. For example, with igniters of 0·45 ampère, the current used for 3 shots should be 0·6 ampère; for 6 shots, 0·8; for 12 to 15 shots, 1 ampère; and for any larger number, 1·2 to 1·5 ampères.

C. S.

DELAYED IGNITIONS OF EXPLOSIVES.

Neue dynamoelektrische Minen-Zündmaschine, Patent Hans Tirmann, und die verspäteten Sprengschüsse. By L. Volf. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1901, *vol. xlix., pages* 221-226, *and* 1 *plate.*

A Tirmann shot-firer has been in use since 1900 at a mine in Karwin, and retarded ignitions of the blasting-charge have been observed with it. After the introduction into France of safety-explosives (grisoutine-dynamite, grisounite Favier, etc.), several accidents happened at the St. Etienne collieries, and these were attributed to the phenomenon of double detonation. It was assumed that in a bore-hole charged with cartridges, only the first was exploded by the detonator, and that the others became ignited after

an interval of a few seconds or minutes. The following accident proved this:—Three holes, each filled with $3\frac{1}{2}$ ounces (100 grammes) of *grisounite-couche*, were bored in the coal, and ignited by 0·052 ounce ($1\frac{1}{2}$ grammes) detonators and three fuses. Three distinct reports were heard, and, as the workmen were going away, a shot which was still smoking exploded and injured one of them; it appeared to have exploded twice. The theory deduced was that the decomposition of a blasting-charge is not the result of a single chemical reaction, but depends on the pressure to which the products are exposed during such reaction. Dynamite, gun-cotton, nitrate of ammonia, and other blasting materials containing nitrates, decompose gradually in the air, and give out nitric oxide, but if they are ignited in a closed space they instantly decompose, without forming a trace of nitric oxide. The first slow process changes immediately into the second, if the free evolution of gas be hindered, and the pressure raised. The reaction produced by a detonator is the same as that by ignition in a closed space at high pressure. Both are so rapid that the whole of the charge is at once converted into gas. But if the ignition be defective the charge may ignite and burn, instead of exploding; it is then said to "cook," and gives off nitric oxide. The explosive power of a charge also varies with its composition, and depends, in grisounite, upon the small quantity of nitro-naphthalin that it contains. If the charge begins to burn, the increasing pressure caused by the gases given off may produce an explosion, and ignite the cartridges one after the other.

Many experiments were made with grisounite-Favier to obtain retarded ignitions, and these, apparently due to the fuze, have also occurred with the Tirmann incandescent igniter. This apparatus consists of a dynamo, between the poles of which a T-magnet rotates, and contact is made with a nut moving along a spindle. The dynamo is made in three sizes:—The smallest weighs 6·6 pounds and at a distance of 328 feet will fire six fuzes simultaneously; the next size fires twelve fuzes at the same distance; and the largest (weighing $26\frac{1}{4}$ pounds) will fire sixty fuzes simultaneously. The current passes through two insulated copper-wires, $\frac{1}{16}$ inch in diameter. The fuzes being attached to the apparatus the current is turned on, the wire of the fuze begins to glow, and an explosion follows. Thus, there are no dangerous sparks between the electrodes. The fuze has an outer casing of metal-alloy containing the conducting wires, the detonating material, a hollow to receive the detonator and the incandescent wire, made of an alloy of platinum and iridium.

At the Karwin mine, twenty holes were bored and fired in three series. The first and second series having been fired from a distance of 260 feet, a loud report was heard, and the workman was proceeding to fire the remaining holes, when a second report ensued, about 15 seconds after the first. It was impossible to tell which of the shots had produced the first, and which the second report, but all had gone off. The bore-holes were about 4 feet deep, and each contained, besides the firing cartridge, five or six others. On another occasion, six shots were fired at a distance of about 130 feet, and there was an interval of a minute or more between the two explosions. Twenty-five experiments were then made to discover the reason for these retarded ignitions. In two, the dynamite did not explode at all, and in several it was only partly burnt, while three miss-fires were caused by the machine.

The writer attributes these retarded ignitions to the use of an instantaneous induction-current which melted the platinum-wire, and to other defects. In

one experiment, two bore-holes of the same size were drilled vertically into the sandstone, filled with similar charges, and their fuzes ignited at the same moment: nevertheless there were two consecutive reports. Possibly the powder in the fuzes was kindled simultaneously, but the products of combustion did not attain the pressure necessary to force out the tamping at the same moment in both holes. Experiments were also made with an inverted detonator, but retarded ignitions (and not miss-fires) were the result. Sometimes in blasting, the detonator may become damp, and is ignited not by the flame of the powder, but by the hot gases generated by the combustion of the dynamite. Retarded ignitions and smouldering miss-fires are dangerous, and should be carefully studied, to determine whether they are really caused by safety-explosives or incandescent fuzes. E. M. D.

THE RUSSBACH POT FOR SOFTENING OR THAWING DYNAMITE.

Ueber Versuche mit dem Russbach'schen Dynamit-Auftaukessel "Thermophor." By Ludwig Würtz. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1901, *vol. xlix., pages* 228-229.

The Russbach pot consists of two cylindrical vessels, fitting one into the other, with double walls, lined with non-conducting material, and provided with a double lined cover. To maintain an average temperature in the pots of say 122° Fahr. for 10 hours, the inner vessel is plunged for 15 or 20 minutes into water kept on the boil, dried, placed inside the other vessel, and the cover replaced. A number of experiments were made to measure the temperature of the walls of the empty vessel, and of its interior. After placing it for 15 minutes in boiling water, the temperature of the walls when withdrawn was 107·6° Fahr., and of the interior 105·8° Fahr. At the end of 5 hours, they were respectively 102° Fahr., and 87·8° Fahr.; and at the end of 10 hours, 62·6° and 53·6° Fahr. The temperature of the outer air was very cold. After keeping the vessel in boiling water for 20 minutes, the temperature of the walls was 111° Fahr., and of the interior, 109·4° Fahr.: after 5 hours, 100° and 91·4° Fahr., respectively; after 10 hours, 93° and 82·4° Fahr.; and at the end of 13 hours, the temperature of the walls was still 53·6° Fahr. The vessel tested was of 305 cubic inches capacity, and if previously heated as described, 8 to 9 pounds of dynamite at a time could be softened in 3 or 4 hours, and 5½ pounds during the next 4 hours. The pot, however, was too small, because the outer cartridges expanded, and prevented the heat from penetrating to the inner cartridges, and a larger one has been made, but not yet tested.

In the writer's opinion this apparatus affords a means of thawing nitroglycerine compounds with greater ease and safety than any other.

E. M. D.

THE TAMPING OF SHOTS IN MINES.

Commission des Substances Explosives: Rapport sur l'Étude de la Question du Bourrage des Coups de Mine. [Official.] *Annales des Mines*, 1901, *series* 9, *vol. xix., pages* 563-578, *with* 3 *figures in the text.*

This report of the Committee on tamping has been approved and adopted by the French Commission on Explosives. The task entrusted to the Committee was the comparison of various methods of tamping, from the

point of view of the utilization of explosives and the dangers in connexion therewith that might conceivably arise. These dangers are of two kinds:— They may originate from the frictional ignition of remnants of the explosive that have remained clinging to the walls of the shot-hole; or from the ignition (by de-tamping) of gaseous mixtures containing fire-damp.

The experiments undertaken by the Committee may be classified in three categories:—

(1) Comparison of methods of tamping, from the point of view of the utilization of explosives. The materials used for tamping were dry quartzose sand, ground very fine; dry clay; water; ordinary damp sand; and clay kneaded up with water to the consistency of putty. The explosives experimented with were:—Grisounite-dynamite containing 12 per cent. of nitroglycerine; gelatine-dynamite of Cugny, containing 92 per cent. of nitroglycerine; Favier rock-grisounite containing $8\frac{1}{2}$ per cent. of dinitronaphthalene; and Favier coal-grisounite containing $4\frac{1}{2}$ per cent. of trinitronaphthalene.

The tabulated results lead the committee to the conclusion that it is difficult to give the preference (in any marked degree) to one method of tamping as compared with another. In practice, they are inclined to think that sand is preferable to clay.

(2) Comparison of methods of tamping, from the point of view of the risks incurred by de-tamping. The general conclusion is that common sand is the most reliable material.

(3) Comparison of methods of tamping, from the point of view of the dangers arising from frictional ignition. The experiments, on the whole, gave negative results; whence the Committee conclude that, although the risk of frictional ignition cannot be dismissed as illusory, it is extremely remote. In fact, if enclosed in properly-made cartridges, no remnants of the explosive should remain clinging to the walls of the shot-hole unless the circumstances are very exceptional.

Summarizing the foregoing conclusions, the Committee finally express the opinion that sand should be recognized as an admissible tamping-material in the case of safety-explosives. L. L. B.

EXPLOSION OF A DYNAMITE-STORE IN THE FÉNELON SHAFT, NORTHERN FRANCE.

Note sur l'Explosion d'un Dépôt souterrain de Dynamite à la Fosse Fénelon de la Compagnie des Mines d'Aniche (Nord). ANON. *Annales des Mines*, 1901, *series* 9, *vol. xx., pages* 521-547, *and* 1 *plate.*

On November 28th, 1900, at 5·15 a.m., a subterranean store of dynamite exploded in the Fénelon shaft, killing 17 workmen on the spot, and inflicting injuries (mortal in 4 cases) on 22 others. Though so appallingly destructive of life and limb, the disaster caused otherwise comparatively little damage: the chambers in which the dynamite was housed were destroyed, leaving an empty cavity, and there were two falls of rock in the neighbouring heading. This dynamite-store was situated on the 1,640 feet level, about 170 feet horizontally distant from the Fénelon shaft, which serves as an upcast for the St. Louis pit. Ventilation is natural, but sometimes (in very hot weather) a furnace is lighted close to

the Fénelon shaft. Although the workings are not fiery, the use of safety-lamps and safety-explosives is compulsory in certain districts of the mine, where slight traces of fire-damp were met with in the course of forewinning. At the point where the workings intersect an unworkable nameless seam (which has a good gritstone-roof, some 25 feet thick), a sufficient space had been excavated to accommodate two chambers, walled and vaulted throughout with masonry, each 6½ feet broad and of a combined depth of 10 feet. The first chamber was closed off from the workings by an oaken door, about 2 inches thick, and the second chamber (the store proper) was shut off from the first in the same way. The atmospheric conditions (as to dryness, temperature, etc.), were such as to preclude any deteriorating or dangerous effect on the dynamite. At the time of the disaster, the contents of the store were: 293 pounds of dynamite and 253 pounds of grisoutine. Both explosives had been received into store in the preceding September, and the inference is that they were manufactured and transported from the factory to the colliery during the hot months.

No actual witness of the accident survived to relate how it happened. The store and its contents, doors and walls were pulverized. At bank, a sharp detonation was heard, and a long tongue of reddish flame shot up from the pit-mouth, giving place almost immediately to clouds of smoke.

After examining the various hypotheses as to the cause of the catastrophe, the author concludes that the man whose duty it was to distribute dynamite-cartridges to the shot-firers was using a naked lamp, and that by some means this ignited one of the cartridges. He had, that morning, taken down the pit, lighted, both a safety-lamp and an ordinary lamp, the latter of which he was accustomed to use on such repairing work as filled up the time that was not devoted to his duties in the explosive-store. It seems fairly certain that neither fire-damp nor coal-dust played any part in the catastrophe. The poisonous gases resulting from the explosion were so rapidly diluted by the air-current (350 cubic feet per second) passing through the mine, that none of the deaths are properly assignable to mere asphyxiation by such gases. L. L. B.

SINKING WITH THE PATTBERG PERCUSSION SHAFT-DRILL AT THE RHEINPREUSSEN COLLIERY.

Das Stossbohrverfahren von Pattberg und seine Anwendung beim Abteufen der Schächte IV und V der Zeche Rheinpreussen in lockerem Gebirge. By L. Hoffmann. *Glückauf*, 1902, *vol. xxxviii., pages* 553-556, *with* 1 *illustration in the text and* 1 *plate.*

In the Pattberg drill, the reciprocating movement of the tool is effected by an oscillating drum, instead of by a lever. The drill-head is made of wrought iron, shaped like an inverted cone, and pierced by a tubular hole from either side, to the centre, where they communicate with a vertical pipe, connected to the hollow drill-rods. A number of tubes, at right angles to each hole, deliver the flushing-water to channels in the steel-cutters. All the stays and struts of the drill-head are of wood.

The first drill used in sinking at the Rheinpreussen colliery measured 21 feet in diameter, 27 feet in height, and weighed 9 tons; but these dimensions were reduced to 19 feet in diameter and 7½ tons in weight as the depth increased.

The mud from the shaft-bottom is raised by two air-lift pumps mounted

on the drill-rods, compressed air being forced down an air-pipe from the surface and discharged near the bottom, into a concentric inner pipe forming the upcast for the flushing-water and mud.

Vertical guides for the drill-rods are erected in the head-frame, and the cable is passed over the head-pulley to a drum which is oscillated by a pitman driven from the crank-shaft of the engine. Partial balancing of the weight of the drill is effected by steam-pressure on a plunger connected to the oscillating drum, and an engine of about 40 horsepower is required. The rope is run out as the sinking proceeds by a special gear, which enables it to run off the oscillating drum without altering the stroke of the pitman. The total weight of the drilling-rods and pipes is 90 pounds per running foot, and the drill makes 50 to 60 strokes per minute, the length of the stroke being 7 to 8 inches. During a complete revolution, the drill is shifted 20 to 60 times according to the hardness of the rock.

In sinking at the Rheinpreussen colliery the preliminary work in loose ground was performed by an elevator, to a depth of 55 feet. The shaft-bottom (30 feet in diameter) was then plugged with 10 feet of concrete. Through this a new shaft, 20 feet in diameter, was sunk, lined with an outer ring of tubbing and an inner wall of brickwork, the tubbing-joints being packed with asbestos instead of lead. This shaft, however, could not be forced lower than 200 feet, and a second shaft 19½ feet in diameter (lined with 2½ to 3 inches tubbing) was constructed.

The average rate of sinking with the Pattberg drill is 3¾ feet per diem, with a maximum speed of 16½ feet on two successive days. C. S.

SINKING IN UPPER SILESIA.

Das Schachtabteufen des Junghannschachtes II auf der Dubenskogrube in Oberschlesien. *By* E. Langer. *Glückauf*, 1902, *vol. xxxviii., pages* 193-195, *with* 3 *illustrations in the text.*

In sinking this shaft, round a bore-hole, to drain off the water into existing workings below, the dry method had to be abandoned at a depth of 33 feet (10 metres) and replaced by sinking tubbings, 19 feet (5·77 metres) in internal diameter, forced down by hydraulic pressure. However, on reaching the solid Coal-measures at a depth of 150 feet (45·7 metres) the shoe could not be driven further; and as, owing to the dip of the strata, one side of the shoe was still in water-bearing sand, it was impossible to keep out the water while clearing out the hard rock under the shoe to the necessary additional depth of about 10 feet (3 metres).

To overcome this difficulty, 104 bore-holes, 10 inches in diameter, were drilled to the desired depth in two concentric circles close inside the tubbing, the holes being arranged to slant outwards. This work was performed by two short-stroke, water-flush percussion-drills, mounted on a movable platform. As, however, the water-flush failed to raise the boring-mud to the surface, dry drills and balers had to be used; and even this method met with but little success, a number of ribs of stone being encountered, which had to be pulverized by means of **x** drills. After the drilling of these holes had formed an annular channel for the sinking shoe, pressure was applied to the sinking-shaft, the weight of which had been increased to 3,000 tons. But, as the shoe could not be forced down, the shaft-bottom was examined by divers, who reported that the shoe was

broken on one side, and that two segments of the tubbing were cracked and bent outwards, possibly on account of insufficient strength. The shaft had therefore to be abandoned, pending the selection of a method for completing it, whether by putting in a concrete plug and fresh sinking-tubbing or otherwise. C. S.

DRAINAGE OF A SHAFT WHILE BEING SUNK IN AUSTRIA.

(1) *Die Wasserhaltung beim Abteufen des Schöllerschachtes in Libuschin bei Kladno.* *By* Victor Kadainka. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1901, *vol. xlix., pages* 561-564, *and* 1 *plate.*

(2) *Verfahren und Einrichtung, beim Abteufen von Schächten ein vorhandenes Bohrloch behufs ungestörter Wasserlosung intact zu erhalten.* *By* Eduard Grosse *and* Josef Srb. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1901, *vol. xlix., pages* 669-670.

The writer describes the draining of a shaft in the Libuschin mine, by means of a bore-hole 6 inches in diameter, intersecting another shaft from which it is 7,500 feet distant. The success which has attended this method of draining has obviated the necessity for pumping, caused by the influx of water.

The sandstone of the Carboniferous strata, of which the Kladno coal-field consists, holds so much water that, when boring for blasting, a feeder is often tapped yielding hundreds of gallons per minute. To utilize a bore-hole, to carry off water, is not a new idea, but it is not so simple as at first sight appears. If the top of the bore-hole be cut level with the surface of the ground, so that the water may run into it easily, pieces of earth or rock may also get in and clog it up. After blasting, the *débris* must be cleared from the mouth of the hole, while the water is rising over it, and sometimes the force of the explosion destroys the hole. Pumping out the water is a laborious process, but if anything goes wrong the pump can be taken out and repaired, though if a bore-hole be stopped up, it cannot be reached until the water has been drawn off.

The difficulties of draining the shaft at Kladno were so great that they were only partly overcome by boring a hole into an adjoining shaft. To keep the mouth clear of *débris*, the top of the pipe was allowed to project 3 feet above the ground, and the water was run into it by means of a siphon-pipe, lowered, from a platform above, into the bore-hole by a hand-winch. A hose is inserted into the funnel of the siphon, a valve at the bottom closed, and air is admitted at the top. As soon as the water comes out at the air-cock, the flow is regulated, and the siphon begins to act. Before blasting, it is drawn out of the way by the hand-winch. To prevent the bore-hole from being injured when blasting, a wooden pipe was at first placed over it, but as a blasting-charge takes effect chiefly in the surrounding rock, it is the part of the bore-hole belowground which must be protected. Just before blasting, therefore, when the siphon was removed, a steel-pipe about 23 feet long and 4½ inches in diameter was inserted into the bore-hole, the length of this pipe extending sufficiently below the blasting zone to preserve it from injury. The projection of the pipe above the ground still caused difficulty, because a piece of rock might fall upon it; this danger was avoided by attaching the upper part to one of the shaft-frames, and placing a cover over it. It was a curious circumstance that every time the siphon was removed, ice was found underneath it, although

the temperature was about 59° Fahr. As the water rushing into the bore-hole never completely fills it, a vacuum is produced, and this acting upon the damp air from the shaft, when it gets inside, instantly converts it into ice, in the same way as the exhaust of an air-compressing engine.

To obviate the inconvenience of using two pieces of apparatus, the lining pipe and the siphon, the writer combined them into one. Over the lining pipe, a wrought-iron pipe, with two bends, was fixed, the other end of which being fitted with a suction-hose, the same effect as that of a siphon was produced. To start the siphon a 1 inch hole is made in the bore-hole pipe, just above the water-line, and as soon as the water flowing in produces a vacuum, the hole is closed, and the siphon acts automatically. By carrying off the water in this way, the shaft at Kladno, which was 18 feet in diameter, was sunk without difficulty, at an average rate of 116 feet per month.

In 1899, Messrs. E. Grosse and J. Srb introduced an invention with the same object, namely to drain the water from a shaft by a bore-hole. The only difference between their apparatus and the one used at Kladno is in the method of keeping the bore-hole clear. A protecting pipe is inserted into it, and fitted with an inner pipe and a strainer, through which the water passes, and is thus prevented from carrying foreign substances with it. The protecting pipe can be raised and lowered at will. In other respects the two inventions are alike. E. M. D.

LINING A MINE ROADWAY WITH CONCRETE.

Charbonnage de Marcinelle-Nord; Puits No. 11: Revêtement en Béton d'un Bouveau. By — GHYSEN. *Annales des Mines de Belgique*, 1902, *vol. vii., pages* 762-768, *with* 4 *figures in the text.*

A cross-measure drift, at the 2,900 feet level, was subject to violent pressure. The first supports used were strong bars and posts set 2 feet apart, but these could not resist the pressure, which was exerted in all directions. It was retimbered in the same way with the same result. A second renewal of the timbering was made with the sets 8 inches apart, but in 6 weeks this also required renewal. Double timbering was then resorted to, each setting being strengthened on the inside by two upright posts supporting stretchers abutting against a bar placed under the centre of the main bars and at right angles to them. This strong timbering maintained the roof for 3 months before breaking; a month later the road was impracticable, and it was decided to concrete it.

The trial was made on a length of 90 feet. The section of the drift after retimbering was 9 feet 8 inches under the bars and 9 feet 2 inches wide at the floor, the sides being made as vertical as possible. The timber-settings were very strong and spaced 3 feet apart, with poling and faggots over the bars and behind the posts. This retimbering was done for a length of 33 feet, and this was at once concreted before the pressure had time to break the timber.

The concreted section of the drift was 8 feet 2 inches high by 5 feet 11 inches at the widest part, and was egg-shaped with a flattened bottom. The minimum thickness of the concrete was 16 inches, save at the centre of the invert where it was 14 inches. The template was made in 4 pieces, two for the sides and two for the upper semicircular portion. The method

of inserting the concrete and its composition are fully described. The cost per running foot was as follows:—Labour, £1 2s.; material, 15s.; a total of £1 17s.

The drift had been finished for more than 7 months, and no deformation nor fissures were observable. Considering that the timbering and four re-timberings had cost not less than £3 per foot, the cost of concreting could not be considered prohibitive. W. N. A.

RAPID TUNNEL-DRIVING.

Driving the Newhouse Tunnel. *By* H. Foster Bain. *The Engineering and Mining Journal* [*New York*], 1902, *vol. lxxiii., pages* 552-553, *with* 3 *illustrations in the text.*

The Newhouse tunnel* at Idaho Springs, Colorado, is now driven 12,860 feet, and six mining companies are already at work on various veins cut by the drift. The rate of driving the tunnel has been materially accelerated: previously, the best record obtained was 160 feet per month, but recently it had made more than 280 feet in single months, whilst in February, 1902, the drift advanced 268 feet. Better records have been made elsewhere, but not in rock of similar character. For steady cross-cut work in granite-gneiss and schist with the dip away from the heading, and where the headings never break beyond the holes, the record is excellent.

After describing the plant and the daily routine of work, the writer states that the rapidity of the driving is due to three causes:—(1) High-pressure air; (2) the use of the Water-Leyner drill for back holes; and (3) the adoption of the premium basis of payment.

For drilling purposes, the air is compressed to 160 pounds per square inch. It has been worked up to this, in steps of 10 pounds, from an initial pressure of 110 pounds. Miners accustomed to pressures of 60 or 80 pounds have little idea how to handle high-pressure air; and it has been necessary not only to train the men, accustoming them gradually to using the high-pressure air, but also to reconstruct the drills so that they would stand it.

The Water-Leyner drill does its work satisfactorily, and the current of water running through the steel-rods keeps the bit cool and in temper, and removes the *débris* perfectly. Without the Water-Leyner drill it was found impossible to drill 10 feet back-holes as is now done daily. The best proof, perhaps, of its economy is the fact that in the month it was introduced, the air-pressure at the same time being raised 10 pounds, the footage rose 20 feet, a gain which has never been lost. There is, of course, a greater breakage at the higher pressure, but the breakage per foot is not more: 400 sharpened drills and a full supply of duplicate parts are constantly kept on hand, so that no time is lost when a part does break.

The third important element in the rapid and steady progress is the premium system. A bonus of £1 5s. (6 dollars) per foot is paid each month for all ground broken over the 160 feet formerly broken, and it is apportioned among all the men who work at the breast. This bonus brings up the wages of the drill-crew from 12s. 6d. (3 dollars) to about 16s. 8d. (4 dollars) per day, and increases the wages of the others by 1s. 7d. to 2s. 3d. (37½ to 55 cents) per day per man. While this premium now amounts to upwards of £100 (500 dollars) per month, the management

* *Trans. Inst. M.E.*, 1899, vol. xviii., page 516.

consider that the money so invested yields larger returns than that spent in any other direction. The men willingly work hard and, when necessary, long hours, rather than lose a round.

For the year ending August 31st, 1900, the total average cost per foot was, including all expenses, £6 (28·8 dollars); or a breaking cost, excluding the cost of permanent track, equipment, etc., of £4 9s. (21·45 dollars) per foot. During the same year, the tunnel advanced 2,760 feet, and last year the annual footage rose to 2,925 feet. X. Y. Z.

THE ASPEN TUNNEL.

The Aspen Tunnel. By A. W. Clapp. *The Engineering and Mining Journal* [*New York*], 1902, *vol. lxxiii., pages* 519-520, *with* 3 *illustrations in the text.*

The completion of the great Aspen tunnel, a part of the cut-off from Leroy to Bear river, on the Wyoming division of the Union Pacific Railroad, has settled a puzzling engineering problem. Leaving Leroy, the new line follows the historic Mormon Pioneer Valley for 11½ miles to Aspen tunnel, which pierces Aspen ridge, one of the eastern foot-hills of the Wasatch Range. Owing to the peculiar difficulties encountered, the construction of the tunnel is of singular interest. In the spring of 1899, the east and west headings were opened. In August of the same year, about midway between the portals, a shaft was sunk to a depth of 300 feet, with the intention of driving the tunnel in both directions from the shaft. This idea had to be abandoned, on account of the large amount of water encountered; besides which, a strong flow of mineral oil was found which mingled with the water. It was not at first thought that this carried any danger, but an explosion occurred in December, 1899, killing 3 men. Preparations were made to draw off and store the oil, but afterwards this course was abandoned, and the working in the shaft discontinued. At the present time, the oil forms a coating of about 2 inches on all water pumped from the tunnel.

After the abandonment of the shaft, excavation was pushed from the ends only. The method was as follows:—A heading was driven by power-drills, 30 feet above grade, for a distance of 16 feet with a diameter of 6 feet, at each side, leaving a core. The core was then removed by hand-labour. Following this operation, the flooring was removed until the proper grade was reached, so as to admit the steam-shovel. One of these shovels was employed at each end, and their capacity was such that as much material was removed in 3 hours as an entire gang of men could remove in 3 days. Following the usual rough timbering, the plumb-timbers of Oregon pine, 12 inches by 10 inches, were put in. When these had been firmly placed and temporarily braced, steel caps, 16 feet by 6 inches by 6 inches, were raised into position forming the arch of the tunnel. The first lift of concrete was then put in where the nature of the ground required it, which was, in fact, for a distance of 500 feet near the middle of the tunnel. This was followed by three other lifts until the entire surface was covered with concrete.

In the construction of the tunnel, three distinct formations of ground were encountered:—The rocky ground was bored by Burley drills and little difficulty was met. Then came shale, which was easily removed by the steam-shovels. Five hundred feet from the western end, however, the real

difficulties of the work commenced. The ground here was like a pot of yeast, or might be likened to the asphalt-beds of Trinidad on a small scale. As soon as air was admitted to the tunnel, it swelled like quicklime. The writer was shown an instance:—A section of ground, 4 feet square, was uncovered to a depth of 1 foot. In 10 minutes, the excavated ground was not merely level but had risen 14 to 16 inches above the contiguous earth. Such a pressure was difficult to overcome. It was thought that girders, 16 inches by 6 inches, would be sufficient, but they were bent like wire as soon as erected, and timbers, 12 inches square, were literally reduced into kindling wood. So sudden was the action of the ground that the men had to run for their lives from a spot in the tunnel where Oregon pine beams, 12 inches square, had just been placed. The effect was like an explosion, the ground swelling from both the bottom and the sides, and entirely closing up the tunnel. A successful result has only been achieved by means of steel rails, 96 pounds per yard laid close together, and covered with 6 feet of Portland cement.

The writer considers that the engineering work represented by the Aspen tunnel scheme would have been absolutely impossible a few years ago. The steam-shovel has been an important factor in the work of reducing grades and filling gulches. Its introduction into tunnel-construction is something new, and has made such achievements as the Aspen tunnel possible.

X. Y. Z.

HIGH-PRESSURE WINDING-ENGINE.

La Machine d'Extraction du Puits Saint-Dominique : Considérations et Expériences sur son Fonctionnement. By RODDE. *Comptes-rendus mensuels des Réunions de la Société de l'Industrie Minérale*, 1903, *pages* 158-162, *and* 1 *plate*.

When erecting a new winding-engine it was thought desirable to reduce the steam-consumption to a minimum, while at the same time preserving the faculty of raising one loaded cage without its being balanced by the other. The three-decked cages carry two tubs on a deck; and the flat manilla-fibre ropes, wound on pulleys, are practically balanced when raising coal. As the caging operations have to be effected by the engine, it was also required that it should be able to let down loads by reducing the speed, by limiting the pressure in the cylinders, the reversing lever being placed as if used for raising a load and the regulator closed. Such arrangements, which had already been adopted at the colliery, also facilitate the caging operations by reducing the number of times that the engine is reversed. As the mean moment to be developed in winding with two cages has been found to be one-third that with one cage only, the problem was to reduce by two-thirds the power of the engine economically, and without complicating the numerous caging operations; and consequently compound engines were excluded, which are wanting in elasticity unless high-pressure steam be frequently admitted into the large cylinder.

Accordingly, two single-cylinder engines, coupled at an angle of 90 degrees on the drum-shaft, were adopted; and, for rendering them economical, the expansion (variable by the governor) was fixed sufficiently high for the regular speed to be attained without throttling the steam. Inasmuch as condensation could not be employed, the higher pressure was fixed at 114 pounds per square inch (8 kilogrammes per square centimetre), in order that at the end of the expansion-period the pressure might be at least equal to the counter-pressure during the exhaust. As the caging operations are

very frequent, the space between th regulator and the admission-valves is often filled with steam, to be again evacuated; and this space was reduced to a minimum by arranging a regulating-valve for each cylinder, both being worked by the same lever.

The cylinders are 31½ inches (80 centimetres) in diameter, with a stroke of 5 feet 3 inches (1·6 metres). The engine was calculated for winding from a depth of 2,300 feet (700 metres) with a steam-pressure of 114 pounds per square inch (8 kilogrammes per square centimetre); but the present depth is only 1,276 feet (389 metres), while the ports are calculated for a pressure of 142 pounds per square inch (10 kilogrammes per square centimetre).

Trials extending over 24 hours showed that the useful work per 2·2 pounds (1 kilogramme) of steam during 24 hours was 79 foot-pounds (10·917 kilogrammetres) and during the period of winding 92 foot-pounds (12·706 kilogrammetres).

While the useful load in winding coal is 3 tons, letting down 6 tubs of gob-material constitutes a load of 4·2 tons; and a comparison of the diagrams in the two cases shows that the work absorbed by the engine in the latter is about equal in regularity to the work given out in the former, while the engine is not strained in an appreciably greater degree. J. W. P.

ACCIDENTS FROM FALLS OF STONE AND COAL IN UPPER SILESIAN COLLIERIES.

Stein- und Kohlenfall-Verunglückungen auf den oberschlesischen Steinkohlengruben. By – GEISENHEIMER. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate*, 1903, *vol. li., Abhandlungen, pages* 115-140, *with* 15 *figures in the text.*

This memoir embodies the results of all official enquiries, conducted during the period between October, 1901 and February, 1902, into the 110 falls of stone and coal that occurred in the collieries of Upper Silesia. The causes of these accidents are considered first of all: in 38 cases, the fall was sudden, no premonitory signs having been observed. In 12 other cases, signs of pressure or crush were apparent before the disaster happened. In 3 cases, stone or coal was loosened by tapping or hammering. In no less than 33 cases, the stone or coal was caused to break down in course of winning, and 18 accidents occurred in process of timbering. The total loss of life amounted to 31, and in addition 85 persons were more or less severely injured. The greatest number of falls occurred in the group of measures which includes the Einsiedel seams: these have apparently a very bad roof. The other group of measures, notorious for the frequencies of falls, includes the Reden seams, and here a notable proportion of accidents took place very suddenly, without any warning sign having been detected.

The foregoing facts are elucidated by a great number of analytical and synoptical tables; and the author points out that, in order to diminish the risk of falls, workers in mines should be compelled to observe the necessary precautions even under the most favourable circumstances. Where the greatest danger might have been looked for fewest accidents occurred, simply because proper precautions had been taken. He suggests certain additional regulations in regard to timbering, etc., in the collieries of the district under notice, the main point being that less latitude should be left to the discretion of the ordinary pitmen, and more responsibility placed on the overmen, etc. L. L. B.

ELECTRIC WINDING-ENGINES.

Electric Hoists on the Comstock. *By* LEON M. HALL. *The Engineering and Mining Journal* [*New York*], 1901, *vol. lxxii., pages* 140-141, *with* 2 *illustrations in the text.*

With the advent of electricity on the Comstock, it became necessary to take up the problem of hoisting from considerable depths, and after a thorough investigation of the then existing electric hoisting machinery, it was evident that in order to meet the conditions of power and service something must be had radically different from the usual run of such machinery. The writer finally decided on the system described in the article, and installed a continuous-rope electric hoist, driven by means of a variable-speed, three-phase induction-motor.

The power is purchased upon a continuous-rate basis, the amount being fixed by a peak-load of 2 minutes' duration. Under these conditions, it has been the aim to secure a hoist that will operate at the highest possible efficiency, and at the same time affect the regulation of the general system as slightly as is consistent with good service. To meet the condition of high efficiency, it is evident that the motor should work continuously at or near full load, and be specially designed for the work which it has to perform. For a continuous full-load condition, the work must be constant at all points in the lift, and the nearest possible approach to this was secured by the adoption of the continuous-rope or balanced system, where the load is reduced to the weight of the rock alone. Then, to secure the necessary variation in speed, an induction-motor with a non-induction resistance in both primary and secondary was developed, the resistance being varied by the introduction of a modified form of the ordinary street-car controller.

The results with regard to efficiency are stated to be remarkably good—75 per cent. efficiency having been obtained under the severest tests. The writer points out, however, that the advantage of this class of hoist consists not only in its high efficiency, but also in its large capacity compared with the size of the motor in use. X. Y. Z.

THE USE OF CENTRIFUGAL GOVERNORS ON WINDING-ENGINES.

Sur l'Emploi des Régulateurs à Force Centrifuge aux Machines d'Extraction à Détente Variable. *By* CHARLES FRANÇOIS. *Publications de la Société des Ingénieurs sortis de l'Ecole Provinciale d'Industrie et des Mines du Hainaut*, 1902, *vol. xii., pages* 214-271, *with* 29 *figures in the text.*

In winding-engines, steam-distribution with expansion variable by the governor is more and more tending to supersede those with full pressure or with fixed expansion; and theoretically an excellent utilization of the steam should be obtained, as the volume admitted at each stroke is exactly proportioned to the work to be performed, while the engine ought to run with perfect regularity. As to the first of these points, the winding-engines to which expansive working has been applied have realized a great saving of steam and therefore of fuel.

The case is, however, by no means the same as to the second point; and many still are the engines in which the working has been found very unsatisfactory, owing to great variations of speed. The sagging and vibration of the ropes soon required suppression of the governor's action on the expansion-gear, and transformation of the engine into one with four distributing

valves with full admission, this change being all the more necessary as safety is of far greater importance than economy of working.

If it is difficult to prove that the breakage of ropes may be caused directly and solely by variations of speed, it is no less true that the vibrations which they set up bring the rope into violent contact with the guides and buntons, and even with the sides of narrow shafts. The deterioration resulting from the repeated shocks at length inevitably reduces the rope's resistance; and in the case of steel-wire it is now admitted that vibration alone greatly impairs the strength. Lastly, it may be readily supposed that, in the presence of this diminished resistance, an unusual effort or unfavourable conditions of working may bring about a breakage, arising from defective working of the winding-engine.

The requirements for a good winding-engine with expansion variable by the governor are:—(1) The steam-admission should be determined in accordance with the work to be done by the engine, shocks and variations of speed being avoided during this transitory period. (2) The expansive working should be obtained after a minimum number of cylinders-full of steam without cut-off. (3) During the lift, the motive work, or power, should follow the variations of the resistance while maintaining the most constant possible speed.

The author examines the conditions for satisfying these three requirements, and arrives at the conclusion that the ordinary centrifugal governor for regulating the expansion of a winding-engine is quite incapable of performing that duty, and can only give the motor a very irregular speed of working. Passing from full admission to the maximum expansion, this working is characterized by great variation of motive effort, manifesting itself in sagging and vibration of the ropes, so much the more marked as the distance between the engine and the pulleys is more considerable.

The writer then examines the modifications that can remedy this faulty working of the governor, and they may be classed under three heads:—(*a*) Addition of a brake, depending on the speed of the engine; (*b*) limitation of the travel of the slide; and (*c*) modification of the isochronism of the expansion-gear, of which actual examples are given, with their effect or results. The writer arrives at the conclusion, that each case must be studied on its own merits, and the solution sought by trials and modifications, which are always very simple, while the time spent in this study is amply repaid by the saving of fuel effected. J. W. P.

WINDING BY GAS-ENGINES.

Gas-engines on the Pacific Coast. *By* G. P. Grimsley. *The Engineering and Mining Journal* [*New York*], 1901, *vol. lxxi., page* 756, *with* 1 *illustration in the text.*

Gas-engines use fuel only at the actual time of working; and mine-hoisting, being work of a more or less intermittent character, may be effected by gas-engines with an economy of fuel. For the past five years, these engines have been built of the vertical type, those from 10 to 60 horsepower having two, and those over 60 horsepower having four cylinders. The double cylinder gives a working impulse on every revolution, thus hoisting the load without jerk. One of the largest Union Gas hoisting engines is now in use on the 400 feet level of the Yellow Aster Mine, Randsberg, California,

and is a four-cylinder double-drum hoist of 130 horsepower. The engine and hoist occupy a space 14 feet by 17 feet, and 6½ feet high, with the levers all brought to one platform. The engine is set 800 feet within the tunnel, and connected with the distillate-tank outside by a 1½ inches supply-pipe. Other gas-hoists are at work in the same mine, and the Pacific Coast Borax Company, near Daggett, California, is using eight of these gas-engines, five of which are driving hoists.

All the Union hoisting-engines are equipped with sensitive governors, which are specially designed to graduate the charge and admit it to the cylinder in proportion to the load. This is accomplished by the use of two valves requiring only one-half the movement of an ordinary single valve-governor. All large engines are fitted with self-starter gear, so that they start as readily as steam-engines. It is claimed that the expense of running these engines on gasoline or distillate varies from $\frac{1}{8}$ gallon per horsepower-hour in small engines to $\frac{1}{10}$ gallon in the larger engines.

X. Y. Z.

SEMI-AUTOMATIC BARRIERS FOR SHAFTS AND LANDINGS.

Barrières semi-automatiques du Puits Saint-Dominique. *By* — Bouchut. *Comptes-rendus mensuels des Réunions de la Société de l'Industrie Minérale*, 1903, *pages* 162-164, *and* 1 *plate.*

The barrier was required to open simultaneously at the front and back of the landing in obedience to a slight effort by the banksman; and, in the absence of this effort, only to remain open when the cage is at the landing, but to close directly the cage descends the shaft or rises towards the pulleys.

Two barriers of perforated sheet-iron, sliding in vertical guides, are connected by wire-ropes with pulleys at the end of a shaft, which carries a third pulley of half the diameter, connected by a rope to the piston-rod of a single-acting compressed-air cylinder, a counterweight on this piston-rod partly balancing the weight of the barriers. When the piston descends in the cylinder the barriers rise; and they are kept raised by an arrangement consisting of a cam and a spring-hook, entering a recess in the periphery of a disc, keyed on the pulley-shaft. When contact ceases between the cage and the cam, the latter cants and releases the hook, then the barrier descends owing to its weight being greater than that of the piston, its rod and counterweight.

The following are the principal advantages of this arrangement:—(1) As the barrier is not moved by the cage, there is less shock and the cost of maintenance is slight, the barriers put in at the Saint Dominique shaft in January, 1902, having required no repairs, and being still in thorough order. (2) The barriers may be placed in front of the openings in the landing for the cages to pass, so that a complete closing of the shaft is obtained. (3) The barrier lowers directly the cage leaves the landing, upwards or downwards, and so there is no occasion to fear an untimely opening of the shaft, when the cage is drawn above the landing. (4) The rise of the barriers is limited, and there is no occasion to guide them as high as the safety-buntons. (5) Lastly, the cage passes these barriers without opening them.

J. W. P.

COMPRESSED-AIR LOCOMOTIVES FOR MINE-HAULAGE.

Compressed-air Haulage. *By* ROBERT PEELE. *Mines and Minerals*, 1902, *vol. xxii., pages* 562-564, *with* 3 *illustrations in the text.*

The author describes the construction and operation of compressed-air locomotives and the arrangement of such systems of haulage. He favours the adoption of compressed air as a motive power, rather than steam or electricity. The compressed-air locomotive solves the problem of secondary haulage in moderately thick seams which are practically level. It can enter all parts of the workings where track is laid, even far beyond the limits of the pipe-line; whereas the electric locomotive is dependent on wiring for every foot of advance. The air-locomotive can thus run its train of cars between the shaft and landings, and also enter the rooms and breasts to bring out the single cars required to make up the train.

At the Empire gold-mine, Grass Valley, California, a small air-locomotive has been in use for four years on the 2,000 feet level. It is one of the Rix type, and runs a train comprizing five cars each carrying 1 ton. The round trip is 5,000 feet, the tank being 3 feet in diameter by 4 feet long, and carrying a pressure of 500 pounds per square inch. The dimensions over all are:—Length, 60 inches; width, 30 inches; height, 52 inches. Gauge of track, 18 inches. Instead of ordinary engines, a pair of Dake rectangular piston-engines are used, they are very simple and compact, and have no dead centre.

The Peerless Colliery, Vivian, West Virginia, has two air-locomotives which have run satisfactorily since 1896. They are of the H.K. Porter type, and of the following dimensions:—Length, 126 inches; width, 68 inches; height, 53 inches; four driving-wheels, 23 inches in diameter. The gauge is 44 inches. The weight is 10,000 pounds, and the trains consist of six cars, each loaded car weighing 8,500 pounds. The capacity of the main storage-tank is 47 cubic feet, carrying a pressure of 535 pounds per square inch; the cylinders 5 by 10 inches; and charging time, 20 seconds. The working pressure in the auxiliary reservoir is 125 pounds. The main pipe-line is 3 inches in diameter, its total capacity is that of the locomotive-tank, and it carries a pressure of 715 pounds per square inch. These locomotives are designed to work on curves of as little as 15 feet radius, they render mule-haulage unnecessary, as they enter the rooms themselves, and make up their own trains. The cost of each locomotive is about £375.

A larger locomotive has been running for five years at the Wilson colliery of the Delaware and Hudson Coal Company. It has three pairs of 26 inches connected driving-wheels, and two tanks with a total capacity of 160 cubic feet, carrying a pressure of 600 pounds per square inch. The pipe-line is 4,100 feet long, carries a pressure of 700 pounds per square inch, and has a capacity seven times as great as that of the locomotive-tanks. In the auxiliary reservoir, the pressure is reduced to 125 pounds. Reheating is employed. The trains regularly hauled consist of thirty cars, each weighing, loaded, 5,850 pounds, although the locomotive has a capacity of fifty cars. The grades vary from 1 per cent. against to 1 per cent. in favour of the load. The round trip of 8,200 feet is performed in 16 minutes, and the haulage-cost per ton-mile is $\frac{5}{8}$ penny (1¼ cents).

The Anaconda copper-mine, Montana, has air-locomotives as follow:—Height, 58 inches; width, 58 inches; length over all, 124½ inches; four driving-wheels, 23 inches in diameter; wheel-base, 3 feet, designed to work on curves of only 12 feet radius. The gauge is 18 inches. The

cylinders are 5 by 10 inches. The pressure in the main tank is 550 pounds; in the auxiliary tank, 125 pounds per square inch. The capacity of the main tank is 47 cubic feet. The total weight is 10,000 pounds. The round trip is 2,400 feet, the train comprizes six cars, each when loaded, weighing 3,450 pounds. The track is nearly level. The locomotive is built to make two round trips with cold air without re-charging, but by re-heating with hot water, three or four round trips per charge can be made. This group of mines has nine compressed-air locomotives at work. X. Y. Z.

THE NEW WOLF SAFETY-LAMP.

Commission du Grisou, Sur une Nouvelle Lampe de Sûreté à Essence : Système Wolf à Introduction d'Air par le Bas, Rallumeur à Friction et Fermeture Magnétique. By G. Chesneau. *Annales des Mines*, 1901, *series* 9, *vol. xx., pages* 493-504, *with* 4 *figures in the text.*

This is a new benzine-lamp, provided with a friction-lighter, magnetic lock, and admitting the air from below. The French Fire-damp Commission, having been requested by the Minister of Public Works to report upon the lamp, state that it presents all the necessary conditions of security for use in fiery mines.

The descriptive portion of the report consists mainly of diagrams, which are apparently considered more instructive than a lengthy verbal description. Proceeding then to recount the tests to which they submitted the lamp, the Commissioners state that they were unable to find any defect in the magnetic lock or to make it work defectively in any way. It cannot be "started" or dislocated by a violent jar, as was formerly possible with magnetic locks.

The illuminating efficiency of the lamp is not greatly superior to that of good oil-lamps at the beginning of a shift, but it has the supreme advantage of remaining practically constant, as the wick is not carbonized, and the supply is continuous so long as there is any benzine in the reservoir.

Provided with its double gauze, and also with a single gauze, the lamp was tried in explosive mixtures of air and gas which were travelling at a high speed, with very satisfactory results as regards its immunity from explosion.

The experiments made in the matter of relighting showed the great superiority, as to safety, of the Wolf friction-fuze over the Seippel percussion-fuze. L. L. B.

THE DETERMINATION OF FIRE-DAMP IN MINES.

Des Observations continues à instituer pour la Détermination des Quantités de Grisou dégagées dans une Mine. By Paul Habets. *Bulletin de la Société Belge de Géologie, de Paléontologie et d'Hydrologie*, 1901, *vol. xv., Procès-verbaux, pages* 465-480.

One of the problems connected with the quantitative determination of fire-damp in mines is how to trace the influence of seismic movements on the presence (in more or less abundance) of the noxious gases.

The author first of all describes the general atmospheric conditions of a colliery, pointing out that it may be defined as a network of subterranean excavations which are being continually modified—are, so to say, in con-

tinuous motion. (He refers here to the opening up of new workings and the abandoning of old, blocked up partly or wholly by falls of rock or waste.) Moreover, in the usual course of events, the circulation of air in the mine, besides varying slowly with the temperatures, undergoes other changes more or less sudden and temporary. It is, then, in an unstable medium that pit-gas is evolved.

From the numerous experiments that have been made by various observers it may be concluded that fire-damp is unequally distributed within the mass of coal, or at any rate, that the permeability of the mass varies greatly from one point to another. It may be observed also that the so-called fieriest seams do not necessarily contain within themselves the most fire-damp, but they give off more than others. On the whole, the author would recommend the classification of fiery mines in Belgium on the basis of a comparison between the quantity of fire-damp evolved and the quantity of coal produced, quite independently of the conditions of ventilation.

It would be easy enough to determine the influence of microseismic disturbances on the normal evolution of gas in a fiery mine, if a fairly permanent increase in the quantity of gas evolved were to correspond to increased seismic activity, and could not be explained on any hypothesis connected with the ventilation or the working-conditions of the mines. But, unfortunately, the normal evolution of gas in fiery mines is complicated by abnormalities. Contorted portions of the seam, sudden thinnings or pinches-out, where the coal has been more or less crushed, give rise to an increased (often sudden and violent) evolution of gas the moment that they are reached in the course of winning. Such "outbursts" are notoriously common in some of the collieries near the southern border of the Belgian coal-field and in those of Bessèges in south-eastern France. They originate in masses of coal so dangerously permeable as to deserve the epithet "explosive," confined within the mass of the compact coal. Many engineers concur in asserting that the greatest danger from these is just when the air drawn out of the workings shows less than its average percentage of fire-damp: a high tenour of fire-damp in the return-airways is held to show that the seam is generally porous, is "bleeding" freely, and that therefore the presence of an explosive mass need not be feared. On the whole, we may conclude that microseismic energy has no influence on such instantaneous outbursts of fire-damp as those just mentioned: if it had any, such influence would be preventive rather than otherwise, as the conceivable dislocation of the compact coal would permit of a natural and slow draining away of the imprisoned gases.

The author discusses briefly the merits of various appliances now in use for determining the velocity and volume (percentage) of gases present in the air of a mine. He recommends for the measurement of the former Mr. Murgue's apparatus (or that of Mr. Fuchs), and for the measurement of the latter the Petit autocaptor, by means of which samples would be obtained for careful analysis in the laboratory. He recommends also the use of the Schultze automatic recorder.

In the discussion on this paper it was pointed out by Mr. Van den Broeck that the experimental enquiry as instituted by the Belgian Department of Mines would not include the systematic study of the evolution of fire-damp and the changes to be observed therein, and he and others urged that representations should be made to their government as to the importance of such an investigation. L. L. B.

GUGLIELMO FIRE-DAMP INDICATOR.

Description d'un Appareil Avertisseur de la Présence du Grisou, du Gaz d'Éclairage, ou de Vapeurs Inflammables dans l'Air. By G. Guglielmo. *Archives Néerlandaises des Sciences exactes et naturelles*, 1901, *series* 2, *vol. vi., pages* 555-562.

The indicator proposed by the author is a modification of the baroscope. This consists of a fairly sensitive balance, to the arms of which are suspended two bodies, which have in atmospheric air the same apparent weight but very different volumes—as for example, a hollow, hermetically-closed sphere of thin brass and a slab of massive brass or lead. Supposing the baroscope to be in equilibrium in atmospheric air, and that 1 per cent. of fire-damp mixes itself with the air, the pressure exerted on the hollow sphere will be decreased by 5 milligrammes for every litre of its cubic capacity. The sphere will thereupon lower its arm of the balance as if a weight of 5 milligrammes had been hung on it, and then by closing an electric circuit it can set one or more alarm-bells ringing. The instrument, which is of very simple and cheap construction, can be set up almost anywhere; and it can also be made portable, so that the miner could, for instance, carry it with him in exploring abandoned workings, etc.

In order to avoid the errors which might arise through differences of temperature and barometric pressure, the author, instead of closing hermetically the hollow sphere, allows it to open into the external atmosphere by a very long capillary tube. It is claimed that, in this way, thermometric and barometric changes produce no effect on the balance, while fire-damp could only penetrate very slowly within the sphere by diffusion through the long capillary tube, and therefore the value of the baroscope as an indicator is practically undiminished. Another method consists in fixing to the beam of the balance longitudinally a small thermometer which acts as a compensator.

L. L. B.

COLLIERY-EXPLOSION IN WEST VIRGINIA.

The Explosion at the Red-Ash Colliery, Fayette County, West Virginia. By W. N. Page. *Transactions of the American Institute of Mining Engineers*, 1900, *vol. xxx., pages* 854-863, *with* 1 *figure in the text.*

The Red Ash colliery was the scene, on March 9th, 1900, of an explosion by which some 50 men were killed or injured, and much property was damaged or destroyed. The colliery is a drift-mine, with entrance on a slope 500 feet above the south bank of the New river. It was ventilated by an exhaust-fan, driven by compressed air, and the workings were laid out for an excellent system of ventilation with an intake-airway of 75 square feet area.

On March 19th, when it was possible to re-enter the mine, the walls and roof of the main entry were found covered with white dust from the floor; farther in, the roof and sides were coated with coked dust; air-doors were found several hundred feet from their original position, etc. A curious reversal in the direction of the force of the explosion was observed, which was probably caused by a secondary explosion, either of gas, or of carbon monoxide produced by the reduction of carbon dioxide (CO_2) in passing over red-hot coke and forming carbon monoxide, which is a combustible (and when mixed with air before ignition, an explosive) gas.

The primary cause of the explosion was fire-damp on which the dust had little or no influence, though when the gas was once ignited it must have

played an important part by adding to the forces evolved. Fire-damp had been found within 4,000 feet of the entrance, but the presence of gas in dangerous quantities had not been fully realized, consequently some of the precautions for a highly gaseous mine were omitted. During a period when the fan was idle on the previous night, gas must have accumulated in the workings; and, on starting the fan in the morning, this accumulation became mixed with air and was travelling out along the return air-course when it was met by a naked light. A. W. G.

EXPLOSIONS IN PRUSSIAN COAL-MINES DURING 1900.

Mittheilungen über einige der bemerkenswerthesten Explosionen beim Preussischen Steinkohlenbergbau im Jahre 1900. ANON. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate,* **1901**, *vol. xlix., Abhandlungen, pages* **473-476**, *with* 2 *figures in the text.*

(1) On September 26th, 1900, between 5 and 6 a.m., an explosion took place at the Count Schwerin pit, Dortmund, whereby 2 men were killed, and 5 injured (2 seriously, 3 slightly). The disaster occurred at the No. 4 level (1,640 feet) of the bituminous President seam: this seam is about 5 feet thick, dips 40 degrees southward, and is far from fiery but extremely dusty. The regulations of May 24th, 1894, had prescribed the use of safety-cartridges when shots were being fired with guhr-dynamite, blasting gelatine, or gelatine-dynamite, and further that two should not be fired simultaneously. Disobedience to these regulations was the primary cause of the disaster.

Although it seems clear that the water-spraying apparatus was at work up to the moment when the shots were fired, this evidently did not suffice to lay properly all the coal-dust in the immediately-neighbouring workings. The notebook found on the body of one of the shot-firers proved that dynamite was being used, without the prescribed safety-cartridges. Two shots were fired all but simultaneously, and the dust created by the first, together with that whirled up from floor and sides, was ignited by the second shot. Fire-damp was not found in the workings, either before or after the explosion, and the possible intervention of fire-damp is therefore eliminated. The flame swept downward through the heading, extending 50 feet westward and 115 feet eastward to the cross-cut leading to the Tom seam. A film of dry coal-dust was found spread over everything at the original site of the explosion, and elsewhere traces of coke were found on the timbering, etc. The dynamic effects were inconsiderable, very little mechanical damage being done. The pit-ventilation remained on the whole undisturbed, so that rescue-work was not attended by any very considerable difficulties. The bodies showed but few burns, and the victims were evidently suffocated by the after-damp. A new regulation has been made, already in force in several other collieries, that master shot-firers are not to be allowed to take dynamite into the pit with them at the same time as safety-explosives.

(2) On the morning of October 12th, 1900, an explosion took place in the eastern district of the Minister-Stein Pit, United Stein and Hardenberg collieries, Dortmund, which resulted in the loss of 5 lives. The scene of the catastrophe was No. 3 north working of No. 1 North Seam, above the 1,023 feet level (lowest level). The coal-seam here varies in dip from the horizontal to 25 degrees, it is rather more than 4½ feet thick, bituminous.

and very fiery. The immediate roof is shale, which often falls in; above this is a sandy shale. The frequently-observed evolution of gas in the form of blowers, etc., is probably due to the occurrence of several small unworkable seams in the roof of No. 1 seam, which contain fire-damp in considerable quantity in a state of great tension. It was the custom in this pit, so soon as the proportion of fire-damp reached 1 per cent., to draw out the vitiated air by means of a system of pipes communicating with a ventilator driven by compressed air; if this failed to reduce the percentage of fire-damp, the portion of the workings thus affected was shut off by masonry-dams. No arrangements were made for water-spraying, as the seam showed but little tendency to dustiness.

In the night of the 9th to 10th of October, 1900, the presence of fire-damp in considerable quantities was observed. Work was suspended in the invaded portion of the pit, and the construction of a dam was started: this was all but completed just before the explosion took place, but the ventilating apparatus (pipes) had to be removed from the abandoned portion of the workings. It appears that notwithstanding distinct orders to the contrary, one of the 5 men employed on this work had climbed over the dam and placed his lamp upon it so as to see more distinctly. There was a rent in the wire-gauze of the lamp; and, in this way, the combustible gases accumulated in the vicinity, and driven forward by the eastward travelling ventilating current, were ignited. The dynamic effects of the explosion were of no great importance: brattices, etc., showed no trace of damage. It is thought that the natural dampness of the pit prevented the coal-dust from becoming the vehicle for the further spread of the explosion. No new regulations have been thought necessary. L. L. B.

EXPLOSIONS OF FIRE-DAMP AT THE PLUTO SHAFT, 1900.

Die Schlagwetterexplosionen auf den Plutoschichten in Wiesa am 13. November 1900. By FRIEDRICH OKORN. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1901, *vol. xlix., pages* 391-394, 405-408, 417-420, 434-436 *and* 443-447, *and 3 plates.*

On November 13th, 1900, two explosions took place at the Pluto shaft, about 4,000 feet from the main shaft of the Bruch coal-mine at Wiesa. In the first, at 2 p.m., 12 men were injured; in the second, just after 4 p.m., 18 men were killed and 7 injured. Among the dead were the manager, two mining engineers, and other officials. The cause of the double catastrophe was the ignition of carbon monoxide and of carburetted hydrogen gases.

An explosion had already occurred in November, 1894. Since then the mine had been enlarged and seven shafts sunk for winding, pumping and ventilation, at depths from 730 feet to 1,200 feet. The draining and ventilation of the mine were considered ample. There are more than 3½ miles of high-pressure air-pipes and 7½ miles of water-pipes. The Pluto shaft employs 650 miners and 306 men above ground, and 1,200 tons of coal are raised per 24 hours, in three 8 hours' shifts. Every three months, according to Government regulations, samples of the air are analysed at the public laboratory. The last analysis, made 2 months before the explosion took place, showed 12 per cent. of fire-damp and 14·9 of carbonic acid; and the writer calculates that about 440 cubic feet of fire-damp and carbonic acid are liberated per ton of coal in 24 hours. The average temperature in the shaft is 84 degrees Fahr. The length of ventilating pipes is about 5,250 feet.

The level where the catastrophe took place was laid out in October, 1900. Works in the neighbourhood had been closed, and notwithstanding all care to the contrary, the dividing pillars gave way, probably on account of blasting, 108 cartridges having been fired in 5 days. Cavities containing inflammable gases were then found in the old workings. On November 5th, this hole was closed by a wooden stopping, which appears to have remained intact, and the foul air to have percolated through the pillar itself. On the further side, another level had, in September, been found insecure, and shut off with a wall built of refuse or gob-stuff. Signs of spontaneous ignition soon appeared, and although water was played constantly upon the wall, a little blue flame could not be extinguished. On November 9th, the manager inspected the level, and found no active mischief. On November 10th, smoke was seen coming from the wall, a hole was made in it and well sprayed with water. Unfortunately, owing to repairs, the high-pressure water-pipe was out of use for the next 24 hours. The next day the wooden dam was observed to be hot, and there was a "bright glow" in the gob-wall, on which water was thrown by hand. On November 12th, it was decided to blast the level, wall it up, and abandon it. Early on the 13th, blasting was begun, and after the fifth shot smoke was observed coming from the wall. In the level, on the other side, no foul air was detected till this day, when a hole being made to test it, a lamp at the mouth was extinguished, and the opening immediately closed up. The main water-pipe, 6 inches in diameter, was by this time in working order, but owing to a misunderstanding the connection was not made till the 12th; and even then the pressure was insufficient. Three weeks before, a wall had been begun at the mouth of the level, but the work proceeded slowly for lack of material. On the 12th, seeing that the fire was increasing, the building of this wall was pushed on in hot haste; and on the 13th, the manager ordered the level to be wholly shut off, withdrew the men, and hurried up materials for finishing the wall, and bricking up the doors. Until this was done he did not quit the spot.

Twelve men were still engaged in the work, when at 2 p.m. the first explosion occurred. The still wet walls were thrown down, and all the men injured. Fortunately, owing to the change of shift, few miners were about. The explosion laid the level bare, and a bright flame was perceived, but no trace of fire-damp. It was immediately decided to withdraw to at least 600 feet from the spot, and three doors at this distance were walled up. The work was supervised by the manager, and carried out by a staff of volunteers. The two nearest doors had already been closed, the men were distributed between the three doors, and the manager was about to test for fire-damp, when the second explosion came. He and two of his assistants were instantly killed, and the rest attempted to escape. One of them managed to crawl to an air-pipe which being open, saved his life; others fled wildly from the scene, and were found dead or died later. Two dead bodies close to the door where the explosion took place were uninjured. All the men in the neighbourhood were thrown down, many doors shattered and most of the lights extinguished; while the level itself was completely wrecked. By 8 p.m., all the bodies had been recovered, and it was then decided to shut off, first with boards and afterwards with cement and mortar a large part of the mine round the scene of the explosion. The work was begun the same night, and carried on without intermission night and day.

The writer considers that the working conditions of the mine do not account for this explosion, since the ventilation was ample. The special danger of spontaneous ignition in a lignite-mine should have been kept in view, and guarded against, and the risk of an explosion carefully avoided until the level had been exhausted. This could have been done by utilizing water at high pressure, but several errors were committed. These were:—(1) Too much blasting; (2) lack of building-materials for the walls; (3) interruption of the water-supply; and (4) want of energy in pushing on the necessary works. It was a mistake to enlarge the level, when the supports were already exceedingly weak. More care ought also to have been exercised in keeping under the conflagration of the gob-stuff. At the moment when everything depended on rapidity in closing the hole, and smothering the fire, fresh blasting loosened the pillar, the wall became porous, and the air penetrating it fanned the flame. Even then, it might have been kept in check had a full water-supply been available, and the building of the wall rapidly pushed on, to cut off the air before it could reach the inflammable gases, but at the critical moment neither was done. It was not till after the first explosion that the extreme danger of the situation was realized. Had a larger area of the mine been then shut off, it would have required too much time, nor could the men be withdrawn too far, and the fire left unwatched. Hence the manager had no choice but to order the dams to be built at the points which he selected, and it would have appeared a breach of duty to abandon more of the mine than he was compelled to do. Faults once committed, he did his best to atone for them, and paid for errors with his life. It was owing to the good ventilation that there were no further explosions, the fire was localized, and did not spread through the mine, as it might have done, with terrible results. E. M. D.

EXPLOSION OF FIRE-DAMP IN THE WIELICZKA SALT-MINE, AUSTRIA.

Grubengasexplosion im Wieliczkaer Salzbergwerke. Anon. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1901, *vol. xlix.*, *pages* 335-336.

On May 9th, 1901, a remarkable explosion of fire-damp took place at the Wieliczka salt-mine, killing 1 man and injuring 2 others. It occurred in an excavation 197 feet long, 130 feet wide, and about 6½ feet high, which had been worked for the last sixteen years without a trace of foul air, and in a part of the mine where the salt, called *spiza*-salt, is not known to contain any gas. No such accident had happened in the district since 1797. Had it occurred where *knister*-salt is present in large quantities, it might have been accounted for. This salt, a special feature of the Wieliczka mine, is of a coarse crystalline character, white and transparent, and smells strongly of bitumen. The crystals are full of small bubbles which at a certain pressure are resolved into marsh-gas, hydrogen and brine. The salt dissolves rapidly in water, the bubbles burst, and the gases escape with a loud crackling report, hence the name *knister* or "crackling" salt. This phenomenon could not have caused the present accident, because the explosive gases were generated in the compact *spiza*-salt. The bed of this salt at Wieliczka contains numerous animal and vegetable fossils, and among them lignite, which when decomposed gives off methane (CH_4). Probably, therefore, there was a larger quantity of this lignite in the

neighbourhood than usual, and a cavity had become charged with fire-damp. This being inadvertently opened by the miners, fire-damp had escaped, and when brought in contact with lights was ignited. This theory is confirmed by the fact that when lignite is occasionally met with in the *spiza*-salt beds, there is always a slight escape of gas, which burns with a small blue flame. The explosion was confined to the roof of the excavation, for three cartridges for blasting, which lay on the ground, together with the fuse and a covered hand-lantern, were untouched. E. M. D.

EXPLOSION AT THE KÖNIGIN-LUISE COLLIERY, ZABRZE, UPPER SILESIA.

Die Explosion auf dem Königlichen Steinkohlenbergwerk Königin Luise, zu Zabrze am 2. April 1903. By — Drotschmann. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate*, 1903, *vol. li., Abhandlungen, pages* 267-286, *and* 2 *plates.*

Shortly before 1 p.m., on April 2nd, 1903, in the eastern district of the Königin-Luise (Government) colliery, there took place in the 1,115 feet level a coal-dust explosion, which cost the lives of 23 persons, and wrought dire mischief over a radius of 2,000 feet. The disaster has made an especially deep impression, because, owing to the general absence of fire-damp in, and freedom from dust of, the Upper Silesian collieries, the occurrence of a coal-dust explosion had been considered by most of the mining officials as highly improbable. It is true that some insignificant dust-explosions had been recorded previously in that coal-field, but as they had never extended beyond a radius of some 150 or 200 feet, no importance had been attached to them.

The shock of the explosion on April 2nd was felt above bank, and it was followed by thick clouds of smoke rolling out of No. IV. shaft. It is reckoned that 191 men and 9 horses were at work in the 1,115 feet level at the time of the disaster, and many were so fortunate as to escape with very slight injury. At 4 p.m., the pumping-engines on that level were set running again, and the electric light was got once more into working order. Rescue-parties went through the workings, and saved some men who were fast succumbing to the effects of the noxious gases. They found several corpses badly burnt, but curiously enough the 6 horses that were killed by the explosion showed no trace of burns.

A detailed description is given of the havoc wrought in the workings.

From the point of view of the cause of the explosion, it is important to note the occurrence of beads and crusts of coke, also of thick layers of velvety sootlike dust, marking everywhere its course. Such dust had never been observed or even suspected in the pit before: probably much of it, in the course of years, had accumulated behind the timbering. Much, however, must have been evolved by the explosion itself. A review of the available evidence connects the disaster with the firing of two shots, wherein an improper use had been made of coal-dust tamping instead of the prescribed "clay." It has been ascertained that the Upper Silesian pitmen cherish (unfortunately) the belief that coal-dust tamping enhances greatly the effect of a shot. The amount used for the two shots in this case was demonstrably not less than 3 pounds. They were fired one after the other, and it is believed that the explosion followed on the second shot, by which

time an appreciable amount of coal-dust would be whirling in the air, ready to flash into flame. Then, too, there was the dust inevitably produced in boring the shot-holes. The author apparently does not believe that inflammable gases were present in the pit in any appreciable volume. The oxygen of the air was quite sufficient, in combination with the coal-dust, to produce the effects noted. Meanwhile, measures are now being taken to water the workings, and a committee has been formed to consider the best means of combating the dangers of coal-dust in the collieries of Upper Silesia. L. L. B.

INFLUENCE OF PRESSURE ON THE PROPAGATION OF EXPLOSION IN GASES.

Influence de la Pression sur la Propagation de l'Explosion dans les Gaz. By Alex. de Hemptinne. *Académie Royale de Belgique, Bulletin de la Classe des Sciences*, 1902, *pages* 761-775, *with* 2 *illustrations in the text.*

Temperature and pressure are all-important factors in explosive phenomena. The author describes a series of experiments which he made with gaseous mixtures, using sometimes very low pressures and sometimes very high ones. For igniting the gases he used the spark produced by a Ruhmkorff coil.

From sundry experiments made with mixtures of hydrogen and oxygen, the author is enabled to infer that the electric discharge determines an explosive wave. The violence of the local explosion causes this to take place at lower pressures than are found necessary when ignition is effected by means of an incandescent spiral of platinum. The electric discharge and the formation of a wave being rather capricious phenomena, it follows that the explosion induced by sparking does not always take place at so definitely-fixed a pressure, as when it is started by the incandescent method. It would seem that certain vibrations are especially favourable to the sudden combination of gaseous mixtures.

Phenomena of the same order were observed in the case of mixtures of carbon monoxide and oxygen, methyl-alcohol and oxygen, ethyl-alcohol, ether, benzol, acetylene and carbon disulphide. The results are summarized in the following table:—

Name of Gas.	Minimum Pressure with Electric Discharge.	Pressure with Incandescent Spiral.	Heat of Formation.	Heat of Combustion.	Temperature of Explosion.	Temperature Mean.	Velocity of Explosive Wave.	Velocity o Combustion.
	In Millimetres of Mercury.	In Millimetres of Mercury.	Calories.	Calories.	Degrees Centigrade.	Degrees Centigrade.	Metres per Second.	Centimetres per Second.
Hydrogen	35	192	—	58,000	530 to 606	568	2831*	5,780
Carbon monoxide	58	145	26,500	68,000	650 to 730	690	1089*	6,700
Methyl-alcohol	45	145	48,800	182,200	—	—	2831†	8,480
Ethyl-alcohol	40	125	53,000	340,500			2774†	8,305
Ether	35	125	56,500	659,600	210 to 240	225	2840†	8,942
Benzol	25	105	−17,100	77,600	—	—	2622†	9,700
Acetylene	15	45	53,200	310,100	185 to 195	180	2482	10,070
Carbon bisulphide	12	14	−28,700	265,100	190 to 210	200	1953†	8,270

* Determined by experiment. † Calculated.

From these results the following conclusions are drawn:—

(1) Explosion, in whatever way it may be started, takes place at lower pressures in the case of those gases of which the heat of formation is negative, than in the case of others.

(2) With the exception of hydrogen, there is a kind of parallelism between the minimum pressure at which explosion determined by electric discharge takes place, and the pressure at which it takes place when determined by the incandescent spiral.

(3) If hydrogen and the substances (the heat of formation of which is negative) be excepted, the minimum pressure, at which a gaseous mixture explodes by sparking, is lower in proportion as the heat of combustion is greater. (The abnormal behaviour of hydrogen under such conditions is doubtless explained by the enormous velocity of its explosive wave.)

(4) There does not seem to be any relation between the temperature of explosion, and the pressure due either to sparking or to the incandescent spiral.

(5) There does not seem either to be any relation between the velocity of combustion, and the limiting pressure at which gases explode by the incandescent method.

On the whole, the more closely the figures in the table are studied, the more it appears that explosion is a highly-complicated phenomenon. One point, however, impresses itself upon us, namely, the undoubted difference in character of an explosion according as it is determined by the electric spark or by the incandescent method. In the first case, the velocity of travel of the molecules seems to play the principal part. In the latter case, the heat of formation, the heat of combustion, and the temperature attained at the moment of combustion, exert a preponderating influence.

Finally, certain experiments at high pressures are described. A mixture of hydrogen and nitrogen was compressed up to 80 atmospheres, yet sparking failed to induce combination to any important extent. A mixture of nitrogen and acetylene was subjected to a pressure of 30 atmospheres, and then on sparking the acetylene was decomposed into hydrogen and carbon, but hydrocyanic acid was not formed (as it is in such mixtures at lower pressures). L. L. B.

THE GIERSBERG LIFE-SAVING APPARATUS.

Der Rettungsapparat Giersberg, Modell 1901. *By* Dr. Felix Busson. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1901, *vol. xlix., pages* 350-352, *with* 2 *illustrations in the text.*

The writer describes a trial made at Gelsenkirchen of a new apparatus for saving life in mines. In all appliances hitherto used for this purpose, the supply of oxygen for breathing must be regulated by the worker, but in the Giersberg instrument the compressed oxygen is fed in automatically and continuously, the energy stored up in it being utilized to expel the carbon dioxide generated by the breath, and thus avoid the accumulation of noxious gases. A mask is placed over the head of the worker, fitting closely round the face by means of an indiarubber tube, but leaving the ears exposed; the voice of the man inside can be heard without difficulty. A bag containing the oxygen for breathing is placed under the chin, and into it the carbon dioxide is also breathed. The rest of the apparatus is fixed like a knapsack on the man's back, his arms being free. It consists of two bottles lying horizontally one above the other, containing compressed oxygen, which passes thence into a tube through a valve regulating the amount required for breathing at a time. The tube, to which a pressure-gauge is attached,

is connected to the bag under the chin, and passes on its way the mouth of another tube, containing oxygen which has been already breathed and regenerated. Above the oxygen bottles is the receptacle for the absorption agent, in this case solid alkali, to which the breath is carried off through a tube on the left of the face. Here the carbon dioxide is absorbed, and the oxygen passes on to the main oxygen tube. The pressure of the fresh compressed oxygen acts as an injector, and carries with it this current of regenerated oxygen from the absorption medium. The two pass together to the right-hand side of the bag, where they force out the breath through the left-hand tube, and the cycle recommences. Thus the spent products of the breath are at once carried off, and do not remain to contaminate the fresh oxygen. Instead of a mask, a mouthpiece only may be used. By means of the pressure-gauge the foreman can see that the apparatus is working properly. It contains enough oxygen to last 2 hours, and during that time requires no attention. An injured man can be carried into safety without the rescuer having to renew his supply of oxygen.

The writer considers the apparatus to be the best yet introduced for saving life in mines, but that the foreman, during the work of rescue, would have too much to do to inspect the pressure-gauges. To make it perfect, the wearer ought himself to know when his stock of oxygen is exhausted, and some indication of this is needed. E. M. D.

OXYGEN AS AN ANTIDOTE AGAINST CARBON MONOXIDE.

(1) *Commission du Grisou: Note sur l'Emploi des Inhalations d'Oxygène dans les Cas d'Empoisonnement par l'Oxyde de Carbone.* *By* Dr. Henri Leroux. *Annales des Mines*, 1901, *series* 9, *vol. xix.*, *pages* 541-543.

(2) *Note sur le Traitement par l'Oxygène à la Pression Atmosphérique de l'Homme empoisonné par l'Oxyde de Carbone.* *By* Dr. N. Gréhant. *Annales des Mines*, 1901, *series* 9, *vol. xix.*, *pages* 544-546.

After pointing out that the use of oxygen as an antidote in cases of carbon-monoxide poisoning was recommended publicly as far back as 1854 by Messrs. Favre and Giannetti, Dr. Leroux recommends the inhalation of oxygen by means of an apparatus which he says is easy to handle. It consists of a cylindrical indiarubber balloon of a capacity of 1,800 cubic inches (30 litres), communicating by means of indiarubber tubing, provided with a stop-cock, with a glass receiver. The receiver has the form of a wide-bottomed flask, closed by an indiarubber stopper, through which pass two bent glass tubes. One tube takes up the oxygen issuing from the balloon, and dips in the water at the bottom of the flask; the other tube takes in the gas which has been washed in the water at the upper part of the receiver and is continuous with indiarubber-tubing provided with a celluloid or glass mouthpiece. If the patient breathes freely, the mouthpiece is introduced into his mouth; if there is any inclination to lockjaw, then the mouthpiece is thrust into one of the nostrils.

The method of using this, and of initiating aspiratory and respiratory movements, according to the condition of the patient, is described. At least 1,800 cubic inches (30 litres) of oxygen must be poured into the lungs, and Dr. Leroux says that there is no harm in increasing this amount to several thousands of cubic inches (hundred litres), according to circumstances.

Dr. Gréhant's investigations bore on two points:—(1) The different action of mixtures of air and of oxygen with 1 per cent. of carbon monoxide. (2) The length of time required to eliminate carbon monoxide from the blood of an animal, according as the animal is permitted to breathe air or oxygen after being dosed with the poisonous oxide.

A dog, which is made to breathe air containing 1 per cent. of carbon monoxide, dies in the course of 20 minutes, but it may live as long as 2 hours and a quarter, or possibly longer, in a gas consisting of oxygen and 1 per cent. of carbon monoxide. The result of the elimination-experiments showed that oxygen is twelve times as potent as air in clearing the blood of living beings of the poison. L. L. B.

COLLIERY-FIRES CAUSED BY SPONTANEOUS COMBUSTION.

Ueber Oberschlesische Grubenbrände durch Selbstentzündung von Kohle und Massregeln zu ihrer Bekämpfung. By — Beyling. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate*, 1902, *vol. l., Abhandlungen, pages* 108-139, *with* 8 *illustrations in the text.*

In the first place, the author gives a sketch of the present state of knowledge as to the general causes of the spontaneous combustion of coal. He then points out how frequent are pit-fires in the Upper Silesian coal-field, especially in certain seams. Those collieries that work the lowest group of Coal-measures, with thin seams, are least often the scene of pit-fires.

As a rule, such fires occur in the goaf, because it is there that the preliminary conditions for spontaneous combustion are most favourable. Moreover, in the case of seams so thick as the main seams of the Upper Silesian coal-field it is impossible to work the coal clean away—a greater or less quantity has always to be left in the goaf; and though the last-named may be carefully dammed off, the ingress of atmospheric air cannot be altogether prevented. On the contrary, as section after section of the workings proceeds, and the goaf is inevitably broken into, fresh air-currents have a constant opportunity of access. Then, too, it is the custom in Upper Silesia, to break down a worked-out place, and thereby the danger is incurred of placing these vast hollow spaces in communication with the surface by means of the resulting rents and fissures.

In open workings, on the other hand, the conditions which favour the spontaneous combustion of coal are generally absent—heaps of the mineral are seldom allowed to lie about there for any length of time. In those cases where workings are heavily timbered, hollows in the roof must be sedulously packed, if fire is to be avoided.

Concerning the interval of time which usually elapses between the commencement of the winning of a seam and the outburst of fire in the goaf, it has been found in Upper Silesia to average between 2 and 3 years. It is impossible, however, in this matter to lay down any hard-and-fast rule: the interval has been known to vary from 9 months to 5 years, and where the regular stratification of the seams is disturbed the time is merely a question of a few weeks.

The author enumerates and describes the preliminary conditions without which a pit-fire (from spontaneous combustion) can hardly arise. These depend on (1) the character of the coal, whether pyritous or not, etc.; (2) the lie of the seams, their thickness, etc., and the character of the roof; (3) the method of working; and (4) the mode of ventilation, though whether this be insufflating or not is of no consequence as regards pit-fires.

He then proceeds to consider the manner in which such conflagrations usually start, and points out that in most Upper Silesian collieries, the outburst of gases of combustion from the goaf has been found to coincide with a sudden fall of the barometer. The actual bursting into flame of the coal is of far less frequent occurrence than the evolution of these gases. Fire in the goaf always tends to travel towards the point from which oxygenated air-currents are coming to feed it.

Some attention is then given to the duration in time and the propagation in space of pit-fires, after which the measures by which such fires are to be combated are considered. These measures are first of all preventive rather than remedial, and they consist in avoiding premature forewinning: in making the drifts (at great cost) of smaller dimensions than formerly; in constructing small, comparatively isolated working-districts; in careful and heavy timbering of the bord-and-pillar sections; in leaving the coal untouched at fissures; in securely damming-off worked-out places, etc. When it is a case of stopping the further spread of pit-fires, the following additional precautions suggest themselves: the immediate erection of dams at important points in the airways, etc.; artificial ventilation by means of modern ventilators; independent ventilation of the separate districts, etc.

It is desirable that such measures should be employed in all fiery mines, but unfavourable local conditions may, of course, enhance the difficulty of applying them. So far as Upper Silesia is concerned, the author points out that there remains one safe method of working when all other means have failed: that is, as working proceeds, to pack immediately the empty spaces with sand. For instance, at the Brandenburg colliery, where the Pochhammer seam is worked, some 23 feet thick, sand-packing is used: the sand is dredged up somewhere in the neighbourhood, and is sent down the pit at considerable expense. In the Myslowitz colliery, the sand is washed down by water through a system of pipes into the worked-out places. The avoidance of the waste of coal which pit-fires occasion amply compensates the cost; not to speak of the far more important considerations of the safety of the workpeople and the general improvement in their health.

L. L. B.

FIRE AT THE "LUDWIGS-GLÜCK I." COLLIERY, UPPER SILESIA.

Der Brand auf dem Steinkohlenbergwerke "Ludwigs-Glück I" in Oberschlesien und seine Wältigung. Anon. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate*, 1903, *vol. li., Abhandlungen, pages* 149-159, *with* 4 *figures in the text and* 7 *plates.*

This fire, which caused damage to the estimated amount of £200,000, started on Sunday, November 19th, 1899, in a shaft by which the middle (or 590 feet) level communicates, apart from the main shaft, with the bottom (or 713 feet) level.

In ventilating the pit, care had been taken to split the air-currents as much as possible, because it was known that at many points the goaf was smouldering. The actual causes of the fire about to be described is unknown: although some smithy-work had been done in the neighbourhood of the shaft up to about 10 a.m. on the day of the disaster, the available evidence tends to disprove any causal connexion between it and the outbreak of fire.

The flames spread with such rapidity, from the moment that the alarm was raised, at 5·15 p.m., that the whole shaft was involved before it was possible to bring the extinguishing apparatus to bear upon it with effect,

and efforts were thereupon successfully directed to walling off the downcast shaft from the seat of fire. The winding-shaft, however, at the upper (or 282 feet) level was invaded by smoke and gases of combustion; and a miner, who attempted to seal up hermetically the aperture by which these made their way into the winding-shaft at that level, was carried to bank unconscious. A rescue-party, who attempted to complete his work, unfortunately took naked lights down with them, and an explosion occurred just as they were about to step out of the cage. The cage was drawn up at once, and the members of the rescue-party were found to be all suffering from more or less serious burns. The immediate result of the explosion was a reversal of the ventilation, and the renewed incursion of smoke and gases of combustion in both the downcast and upcast shafts. It was known that 11 miners were in the pit, but all hope of saving them (if still alive, which appeared impossible) was abandoned, and both shafts were now sealed down. In the course of this operation, a second explosion took place, as the gases of combustion streaming up from the Guido shaft caught fire at a lantern carried by a workman. The buildings around the pit-head were immediately wrapped in flames, and the most strenuous exertions of the fire-brigade were needed to save the boiler-house, the coal-screening apparatus, etc.

Although the fire was got under after several hours' work, there remained the problem of avoiding the drowning-out of the pit. It was estimated that water would begin to rise in the workings 36 hours after the underground pumping-engine had stopped, and to check this it would be necessary to make the winding-shaft accessible down to the bottom-level. After various searching tests had been applied, with the view of ascertaining the conditions and composition of the atmosphere in the pit, that shaft was reopened on December 30th, and the upper level was reached on the same day, the ventilator there being found uninjured, despite an explosion having taken place in its immediate neighbourhood. A search-party (provided with pneumatophores, although measures were taken to ventilate the pit provisionally) found a day or two later the bodies of the 11 missing men: some of them appeared to have been asleep when death overtook them.

In order to drain the pit eleven pumps altogether were erected: with the first two, pumping was begun on February 4th, 1900, but the work of drainage was only completed in September 1901. Many unexpected difficulties had been met with, and moreover the necessity of simultaneously contending with the fire still burning in some of the underground workings, had constituted a formidable obstacle.

It may be mentioned here that two electrically-driven pumps (the others were driven by steam) proved especially serviceable, and were found very seldom to need repairs of any kind. The underground pumping-engine was found to have suffered so little damage that it was set at work again a fortnight after the deep-level had been made accessible.

A detailed description is given of the gradual methodical way in which the fire was fought out of existence inch by inch, month after month; but, even when this had been accomplished and the pit had been drained, much remained to be done. No less than 40,000 feet of haulage-way, etc., had to be cleared of refuse, 150 masonry-dams to be rebuilt, and about 20,000 feet of pit-props to be replaced. It was not until October 1902 that the colliery reached its former output, and the management are still burdened with expenditure which can be traced back to that unlucky Sunday afternoon in the late autumn of 1899. L. L. B.

FIRE IN A COLLIERY AT WALDENBURG, SILESIA.

Der Grubenbrand im Hermannschachtfelde der Cons. Fürstensteiner Gruben bei Waldenburg i. Schl. am 24. Mai 1901. Anon. [Official]. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate*, 1902, *vol. l., Abhandlungen, pages* 92-97, *and* 1 *plate.*

The Consolidated Fürstenstein collieries at Waldenburg are classed among fiery mines, but it so happens that No. 10 district of the Hermann pit, in which the fire herein described occurred, is free from fire-damp. The only lights used are safety-lamps of the Wolf pattern. The ventilating-shaft, in the north-eastern angle of the property, goes down 275 feet to No. 9 seam (the fourth level), and besides serving the purposes of ventilation was chiefly used by the miners for travelling to and from bank in wooden cages. Only a small number (those who were working at the middle level) went up and down by the Hermann shaft. On May 24th, 1901, shortly after 3 p.m., the timber-shed built over the ventilating-shaft, in some unexplained way, burst into a blaze. It was in a small fir-plantation on the Butterberg, many hundred yards distant from dwellings or workshops, and somewhat over 100 yards south of the old high road from Waldenburg to Altwasser. The building of a fire-proof shed had been insisted on by the mining authorities, but as so much other constructional work was going on at the colliery, and the chances of fire appeared remote, the rebuilding had been by permission postponed and was to be carried out in the ensuing autumn. All those who went down the pit for the afternoon shift between 2 and 2·30 p.m. had locked safety-lamps; there is evidence to prove that no one was smoking among the late comers, and the fire can only be attributed to incendiarism. All efforts to trace the criminal have proved so far unavailing.

The conflagration soon spread to the timbering of the shaft, and this being a downcast and the ventilators being at work, the flames and smoke were drawn down into the pit. Water was not at hand, and a vain attempt was made to stifle the flames by shovelling earth into the shaft. The alarm was spread through the pit, and by stopping the ventilators the burning shaft was turned into an upcast: it was by that time past 4 o'clock, and the suffocating gases had now spread through a considerable portion of the workings. In a futile endeavour to escape, 17 men met with their death, and 1 man was killed at the working-face. Up till about 5 p.m., 22 men came, one by one, safely to bank. Then the rescue-parties commenced their heroic work, and laboured (unfortunately with the loss of 2 more lives) until 11 p.m., when it was found impossible to advance farther into the workings. One man found completely unconscious was restored to life by insufflation of oxygen from the oxygen-holders which the rescuers brought with them.

Meanwhile, a long procession of water-carts was brought up to the pit-mouth, and the hose was vigorously played on to the burning shaft. About 6 a.m., on May 25th, it became possible to get into the shaft, and then to attack the burning No. 2 seam, which had caught fire from the blazing timbering at the uppermost level (30 feet or so below bank). The men, who were chosen to accomplish this task, were sent down in a cradle suspended by a rope, and were provided with smoke-proof masks. About noon, their efforts were so far successful that it was possible to restart the ventilators, and temporarily to retimber the burnt-out portion of the shaft. The rescue-parties then entered the pit by that shaft as well as by the

Hermann shaft, and penetrating into workings which they had hitherto been unable to approach found about 9 p.m. a hewer still alive, although he had spent about 30 hours, mostly in a comatose condition, in an atmosphere of poisonous gases. He was brought safely to bank.

The circumstance that the rescue-parties, during the actual progress of the conflagration, had been able to travel a comparatively long distance through the workings, is attributable to their having taken with them the oxygen-holders from the pneumatophores. It was not considered desirable to equip the rescuers with the pneumatophores themselves, on account of the very low roofs under which they needs must pass, and such like difficulties.

L. L. B.

FIRE AT POCAHONTAS MINES, VIRGINIA.

Disaster at Pocahontas Mines. *By* CHAS. S. THORNE. *Mines and Minerals*, 1902, *vol. xxii., page* 262.

The Baby and West mines, at Pocahontas, form part of a group of five mines, the other three being entirely separate, but the Baby and West mines are connected underground.

On November 14th, 1901, at 4 a.m., a fire was discovered in the Baby mine exhaust-fan. Further examination disclosed fires at four different points near the main entry and the fan-entry of the Baby mine, all fairly well under way, separate and distinct from each other. The first of these was found about 700 feet from the Baby mine pit-mouth on No. 1 entry on the straight mine-track. At 5 a.m., a fall of roof caused a disturbance of the gases gathered in the rear of the fire, resulting in a slight explosion. Without injuring any of the exploring party who were within 50 feet, the explosion blew out some brattices, permitting the smoke and gases to pass through the old workings of the Baby mine into the West mine, and, before warning could be sent, 9 men were suffocated in the West mine at a distance of 1 mile from the site of the fire.

When it was found that the smoke was drifting into the West mine, the fan at the Baby mine was started, in order to draw the smoke from the West mine over the fire in the Baby mine and thus give fresh air to the West mine. The result was, that the gases previously generated by the fire and drifted with the smoke, were carried back mixed with fresh air over the fire, and a second explosion occurred between 9 and 10 a.m. No one, however, was seriously injured thereby. In fact, no fatalities occurred in the Baby mine or within 3,000 feet of the site of the fires.

The bodies of the 9 men suffocated were recovered a day or two later, but a distressing occurrence was to follow. It was found that the West mine could not be worked while the Baby mine-fire was in progress, and after putting up some brattices partly separating the two mines, the superintendent, Mr. W. O'Malley, the engineer, Mr. F. Bell, the general manager, Mr. Joseph Cardwell, Mr. A. S. Hurst, the mine-inspector, Mr. W. Preece, and the coal-inspectors, Messrs. W. Oldham, M. St. Clair and R. St. Clair, making a party of eight, went into the West mine at noon on November 22, to make investigation of the conditions. At the time the party entered, the West mine fan had been running for 8 hours at 30 revolutions per minute. The party left directions as to what doors were to be left open. This gave them good air to a point about 1,500 feet in, but they went beyond this point, and it transpired that the brattices between the mines did not completely cut off the gas, which thus drifted up into

the higher workings of the West mine. The party passing beyond the shorter circuit of ventilation entered these higher workings and were suffocated. This gas was white damp or carbon monoxide, and had the distinct odour which accompanies coal-distillation. After more brattices had been put in, the 8 bodies were recovered on November 24 at a distance of about 2 miles in the West mine, all the party having died from suffocation.

The system of fighting these fires had been to supply them with water through pipes extended into the workings, and after these pipes were extended, to seal off the old entries with curved brick-dams. The pipes extending through these dams have been used for flooding the district in which the fire is located. In this manner, the fire is being gradually extinguished. The West mine, through which gas and smoke naturally drift on account of the higher elevation, is also being cut off from the old section of the Baby mine by brick brattices and dams, in place of the temporary wooden brattices. X. Y. Z.

EXPLOSION OF A PIT-HEAP IN GERMANY.

Explosion auf einer Bergehalde. By — Pommer. *Zeitschrift für Praktische Geologie*, 1902, *vol. x., page* 381.

At about 2·30 p.m. on Sunday, May 25th, 1902, an explosion took place on the heapstead of the Kaiser-Friedrich pit at Barop. Great masses of the pit-waste were hurtled through the air into the neighbouring gardens, and these were at the same time flooded by the water escaping from the spraying-tanks at the heapstead.

As this heapstead, the internal portion of which was on fire, was being sprayed with water pumped up for that purpose (at the rate of 52 to 70 cubic feet a minute), it may be inferred that the water coming into sudden contact with a focus of combustion had flashed into steam, and thereupon torn up the pit-heap with explosive violence. Onlookers said that the explosion was accompanied by a report like a clap of thunder, while a great column of flame shot up into the air.

The mass of material thus "moved" is estimated at 14,000 cubic feet, and many of the fragments strewn over the neighbourhood weighed as much as 1 cwt. Most of the pit-waste so found is baked red. A steep, crater-like depression was formed in the heap, 13 feet in depth.

L. L. B.

INRUSH OF WATER AT THE KOMMERN COLLIERY, BOHEMIA.

Der Wassereinbruch am Jupiterschachte in Kommern (Böhmen) am 14. Jänner 1902. By Friedrich Okorn. *Berg- und Hüttenmännisches Jahrbuch der k. k. Bergakademien zu Leoben und Přibram und der königlich ungarischen Bergakademie zu Schemnitz*, 1903, *vol. li., pages* 63-133, *with* 3 *figures in the text and* 4 *plates.*

On January 14th, 1902, about 11·45 a.m., an inrush of water took place in the Jupiter pit of the North Bohemian Colliery Company at Kommern, whereby the manager, three other officials, and 39 pitmen lost their lives; 80 others found safety in flight, most getting out by the Jupiter shaft, and a few by the neighbouring Guido shaft.

The invading waters came from above. They had accumulated in fissures and depressions over the roof of the workings; and, on the breakdown of a certain area in the eastern district of the colliery, the waters poured in, sweeping away dams and pillars, and engulfing the unfortunate miners, warned too late by the alarm-signals. The manager himself, apprised by the alarm-signal in his office that something was wrong, hastened down the pit to meet the fleeing crowd, and was among those overtaken by the flood. The point where the water burst in is 2,160 feet north-east of the Jupiter shaft, and 2,300 feet south-east of the above-mentioned exit into the Guido pit.

The Biela river, which flows through the coal-field with many windings from west to east, overflows its banks at least once a year, and vast areas lie under water for weeks together: at such times, the drainage or regulation of the accumulations of water which overlie the colliery-workings is simply impracticable. Public works on a vast scale are needed to regulate the river and deepen its bed, and the necessity for these has long been recognized.

Already in May, 1898, an inrush of water had taken place in the Jupiter pit, whereby 2 persons lost their lives; and, in consequence, very strict rules had been drawn up by the mining authorities in regard to the further working of that pit: these are recapitulated in detail by the author. The government inspectors of mines watched the enforcement of the new rules, and their report of August 10th, 1900, embodied no complaint of laxity or neglect. Towards the end of March 1901, the management had to report an inflow of water of comparative unimportance in the eastern district, and as a consequence certain portions of the workings were securely dammed off. The Government inspectors of mines again reported favourably as to the state of the pit on September 27th, 1901; the workings were kept perfectly dry by electrically-driven pumps stationed above bank.

The testimony of the survivors from the disaster of January, 1902, is given in great detail, and makes interesting reading. One gathers, on the whole, that such confidence was felt in the precautionary measures which had been taken against the inrush of water, that in many cases the true nature of the catastrophe was not realized at first. Yet for several days previously, ominous cracks had been heard and other signs had been noted of a possible breakdown of the workings at the very point where the inrush took place, but the dam walling off the goaf had been strengthened on January 8th (6 days before the disaster), and thus no great importance appears to have been assigned to the above-mentioned warnings. From January 2nd onwards, heavy rains had fallen, the Biela river was in flood, and the surrounding country must have presented the appearance of a great lake.

The water in the drowned pit subsided very slowly and irregularly, but by dint of immense exertions and the addition of four electrically-driven pumps to the two already at work, the pit was at last made accessible on April 14th, 1902. Working has not, however, been resumed in it so far.

The author sums up carefully the available evidence as to the circumstances of the disaster and the conditions of the pit, and concludes that no blame is justly attributable to the management. L. L. B.

UNDERGROUND ELECTRIC PUMPING-ENGINE AT COURRIÈRES COLLIERIES.

Note sur la Pompe électrique de la Fosse No. 9 des Mines de Courrières. By — Bar. *Comptes-rendus mensuels des Réunions de la Société de l'Industrie Minérale*, 1903, *pages* 68-71.

The electric pumping-plant is calculated to raise 44,000 gallons (200 cubic metres) of water per hour from a depth of 820 feet (250 metres). The plant consists, on the surface, of a twin Corliss engine, coupled directly to a flywheel alternator, giving a triphase current of 2,000 volts; and underground, of an asynchronous motor receiving the current, and driving by belts a three-throw pump at the 600 feet (184 metres) level, where the water collects in a lodge of 110,000 gallons (500 cubic metres) capacity.

The cost of the plant, not including the surface or underground engine-room, amounted to £6,400 (160,000 francs); and at first the specified volume of water was raised. With a view, however, to avoid the shocks due to fast running, the three suction-valves and three delivery-valves are each constituted by four clacks, with superposed seats of decreasing diameter; and this arrangement has not continued to give the desired results, for the following reasons:—(1) The clack consists of a gun-metal disc and a cast-iron guide ring, connected by rivets, with an intervening leather washer for increasing the tightness; and this washer, more or less supple, between two parts that require to be rigidly connected, causes their dislocation and leads to fracture. (2) The cast-iron seats afford a large total sectional area; but each one is narrow, so that the water is wire-drawn, exerts great friction on the sides, eats them away and soon renders the valves unserviceable. J. W. P.

PUMPING ON THE KASELOWSKY SYSTEM.

Visite des nouvelles Installations de la Compagnie des Mines de Montrambert et de la Béraudière : Puits Ferrouillat. Anon. *Comptes-rendus mensuels des Réunions de la Société de l'Industrie Minérale*, 1903, *pages* 155-156.

This pump, which delivers with remarkable regularity, is capable of raising 39,600 gallons (180 cubic metres) of water per hour from the depth of 2,132 feet (650 metres); but at present the depth is only 1,510 feet (460 metres). The force-pump on the surface, with pistons, 5·67 inches (144 millimetres) in diameter, makes 20 double strokes per minute, and is driven by a compound steam-engine with cylinders, 28½ inches (725 millimetres) and 47·24 inches (1,200 millimetres) in diameter respectively and a stroke of 47·24 inches (1,200 millimetres). The boiler-pressure is 114 pounds per square inch (8 kilogrammes per square centimetre). The pipe leading the motor-water down the shaft is made of drawn steel, without weld, 2·76 inches (70 millimetres) in inside diameter; and the return-water pipe is of lap-welded wrought-iron, 8·86 inches (225 millimetres) in inside diameter at the bottom, increasing to 9·06 inches (230 millimetres) above.

The underground pump has four plungers, coupled two and two, 10·24 inches (260 millimetres) in diameter and a stroke of 31·50 inches (800 millimetres). J. W. P.

COAL-WASHING.

Considérations sur le Lavage des Charbons: Contrôle du Fonctionnement des Appareils par l'Étude graphique de la Nature et de la Composition des Mélanges traités. By PIERRE CHARVET. *Bulletin de la Société de l'Industrie Minérale*, 1903, *series* 4, *vol. ii.*, *pages* 535-572, *with* 11 *figures in the text.*

As collieries are exhausted, it becomes necessary to work seams of inferior value in regard to the ash-content or the proportion of small coal; and it is almost a general rule that coal becomes less and less bituminous, and therefore less easily utilizable, as the depth increases, so that the importance of washing is evident. In this problem, the following are the three main points to be attained:—(1) To obtain saleable products as pure as the consumer's interest requires; (2) to reduce the waste, or loss, to a minimum, that is, to obtain the greatest possible yield; and (3) to keep the cost of labour as low as possible.

The striving after a reduction of the cost of labour has brought into use plant of large capacity, in which all the manipulations are effected mechanically, so that it is not unusual to see only one man in charge of various appliances that wash 350 or even 400 tons of coal in a single shift. However capable may be the workman, he is not infallible; and the least mistake is of great importance, so that the necessity arises for keeping a permanent check upon the quality and quantity of the products. The quantitative yield may be calculated with sufficient approximation; but it is far from being the case as regards the quality, that is, the ash-content. There is, however, great difficulty in taking from a stock of small coal a series of samples, whose mean ash-content approximately represents the bulk; and when the samples are taken, and analysed by workmen or employees who may find it more convenient, sometimes even less compromising, to furnish incorrect rather than true results, the matter becomes difficult.

Laboratory-tests are therefore only conclusive when a sure and rapid check can be kept upon them; but, supposing the check on the laboratory to be as perfect as may be desired, if the tests indicate the results, they do not show the value of the results. A standard of comparison is wanted for giving information as to the mixture treated, and any advantage that there may be in modifying the method employed. Such a guide can only be afforded by washing-tests on a far larger scale; but these are made with difficulty, so that it would seem very useful to have a laboratory-apparatus and a method capable of taking their place, while at the same time showing that the supervision of the washing-floor is sufficient. The empirical tracing of graphic curves appeared to the author convenient for attaining these two objects; and he describes the method of obtaining them and of analysing, interpreting and representing geometrically certain results which they afford.

From the aspect of the empirical curves obtained it is possible, by comparison with corresponding theoretical curves, to deduce such hypothesis as may appear well-founded, concerning the nature of the mixture and the intimate constitution of the grains composing it. It follows that, for a given state of division, we may, by comparing one with the other and with the theoretical curves various curves afforded by different coals, obtain valuable indications as to the nature of the seam and the purity of the still unwrought coal. We can in this manner clearly ascertain whether the alteration of the coal that requires washing is natural and inevitable, or

whether on the contrary, as is too often the case, this alteration is artificial and caused by the method of working, defective in this respect, or from want of care in the actual getting.

By making a series of tests on one and the same quality of coal, while varying within predetermined limits the dimensions of the grains, a series of curves will be obtained which, compared with those corresponding with a uniform dimension of the grains, will show up to what point it may be advisable to push the previous volumetric classification, in order to give the density sufficient preponderance.

Normally, all coals to be washed, from the different seams or districts of a colliery, go to form an average mixture, which is not very subject to sudden variations, but nevertheless changes insensibly and continually. On the other hand, contracts and conditions of sale become modified, so that it is necessary to make complete tests from time to time. In this case also a check by the curves is indicated, and shows whether the work of the washing-floor is commensurate with that of the small washery, and consequently whether the classification obtained by the full-sized plant comes sufficiently near to the best, or ideal, classification. Lastly, in the case, which frequently occurs, where the washing-plant comprises different appliances, comparative trials may show conclusively which kind of washers are best suited for this or that kind of coal. J. W. P.

THE WILFLEY TABLE: EXPERIMENTAL TESTS.

Lake Superior Developments. *By* Horace J. Stevens. *Mines and Minerals*, 1901, *vol. xxii., page* 71.

One of the most exhaustive tests has been completed at the Wolverine mill. The Wilfley table was run side by side with an Evans slime-table. The round table in 3½ days saved 2,255 pounds of straight slime from the boxes, without tossing, the slimes assaying 3·4 per cent. of copper. After tossing, the weight was only 90 pounds, carrying 16·45 per cent. of copper. The tailings from the round table assayed 0·49 per cent. of copper. These tailings were run over a Wilfley table immediately after leaving the round table, and the latter saved 600 pounds of slimes assaying 4·18 per cent. of copper. The tailings from the Wilfley table in this case assayed 42 per cent.

Side by side with the round table, another Wilfley table was run for the same time on slimes identical in nature. The Wilfley table saved only 735 pounds of slimes before tossing, but the percentage of copper therein was 13·98, and the weight, after tossing, was 390 pounds, averaging 18·23 per cent. of copper. Fed alike, in this competition, the round table saved three times the weight of the Wilfley table in slimes, but after tossing the weight of the round-table slimes shrunk to 4 per cent., while the much smaller product of the Wilfley table remained at 53 per cent. of the original weight. The net saving, on identical matter, was 14·8 pounds of refined copper by the round table, and 71·09 pounds by the Wilfley table. To complete the test, the tailings from the second Wilfley table were run over an Evans table. The assayed percentage of copper in the tailings of the Wilfley table was 0·23 per cent. From these tailings, the round table in the train of the Wilfley table secured 1,040 pounds of slimes assaying 2·51 per cent., making 22·36 pounds of refined copper, and the tailings assayed 0·18 per cent. The round table uses about 100 gallons of water per minute, while the Wilfley table averages only 6 gallons. X.Y.Z.

A MODEL TRAMWAY AND SAMPLER.

A Model Tramway and Sampler. By JAMES H. STEELE. *The Engineering and Mining Journal* [*New York*], 1901, *vol. lxxii., pages* 596-597, *with* 3 *illustrations in the text.*

Ore-Sampler.—On June 1, 1901, the Silver King Mining Company of Park City, Utah, put its new 250 tons automatic sampler and aerial wire-rope tramway into commission. The working of both has been practically perfect since the first run. The sampler is entirely automatic in operation. It is regularly run by 3 men, the foreman, helper and engineer. In the second week of its run, a lot of 175 tons was put through in 5 hours. To show the automatic properties and general efficiency, it is stated that the constructing engineer assisted by the writer put through 165 tons of crude ore in 3½ hours, from the time of opening the feed-gate till the duplicate samples were in the assay-office. This run was made under every-day working conditions, except that the entire regular crew, including the engineer, was laid off.

The sampler-building is 71 feet by 52 feet (exclusive of the engine and boiler-rooms) and is 95 feet high, having 5 floors. The receiving-bins are four in number, resting on masonry pillars, and have a capacity of 250 tons each. The four shipping bins, in front of and below them, are similar. A Robins belt-conveyor, 24 inches wide, carries the ores from three of the bins to the initial crusher, the gate of the fourth bin being placed directly over the crusher. The conveyor delivers the ore to a Comet gyratory crusher with a capacity of 50 tons per hour. There are 5 elevators in the sampler, side by side, with their boots all on the same floor.

No. 1 elevator handles the entire product from the crusher, and has a belt 2 inches wide. From the head of this elevator the ore passes through a Vezin sampler where 20 per cent. is cut out for a sample. The 80 per cent. of "reject" falls to the boot of No. 3 elevator, which handles the reject from all the samplers, using a belt 12 inches wide. The ore passes from the elevator to a hopper provided with a revolving spout, by which the ore may be directed to any one of the four shipping-bins. The 20 per cent. sample passes through a pair of high-speed rolls, and is crushed to pass through a ¾ inch screen. No. 2 elevator raises the sample to No. 2 sampler, where another 20 per cent. cut is made. The reject follows the same course as before, the sample going to a pair of rolls which crush to ⅜ inch. This product is elevated and sampled as before, and the remainder reduced to 8 mesh. It is now passed through a twin sampler which cuts out duplicate samples of about 300 pounds each, and these fall into small bins above the sample-grinder on the roll-floor. The contents of these bins are in turn passed several times through the sample-grinder, where they are reduced to 40 mesh and to about 10 pounds in weight. These final samples, after being ground to pass through 200 meshes and steam-dried, are ready for the assayer.

Aerial Tramway.—In the past, the ore from the Silver-King mine has been taken by wagon to the McIntosh sampler at the lower end of Park City. The road was costly to keep in repair and difficult to keep open in winter, and a rope-tram seemed the simplest and best means of obviating the difficulty, whilst the large output of the mine warranted the construction of a sampler in connection.

The tramway is of the Finlayson type, and lies along the ridge of hills to the north of the mine and down a sharp incline to the lower end of Park City. It is supported on steel towers, varying in height from 16 to 65

feet. The greatest distance between supports is 200 feet. The line is over 7,000 feet long, and has a fall of 1,000 feet. There are 80 buckets spaced 175 feet apart on the line, each having a capacity of 500 pounds of ore and 325 pounds of coal. The present speed is 150 feet per minute, but the speed of the line or the number of buckets, or both, may be increased at any time as the mine-output may require. The ropes are of crucible-steel, the breaking strain being 100 tons per square inch. The traction-rope is $\frac{3}{4}$ inch in diameter; the standing rope on the down side is $1\frac{1}{8}$ inches, and that on the up side 1 inch, in diameter. The idler-pulleys on the towers are lubricated, and the standing ropes are tarred, automatically. All the mine-and-mill supplies are carried by the tram. The weight of the descending ore develops power to run the tram and three supply-elevators at the lower terminal. The tramway enters the lower terminal station at Park City at a height of 85 feet above the ground. The automatic unloading device and the coal-and-supply loading apparatus are located on this floor. The ore is dumped into a hopper placed at the common corner of the four bins with which this station is supplied, and a revolving spout is used to direct the ore into any one of these. X. Y. Z.

CEMENTING-MATERIALS FOR BRIQUETTE-FUEL.

Bindemittel für Brennstoffbriketts. *By* Dr. — Steger. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate*, 1902, *vol. l., Abhandlungen, pages* 311-320, *with* 6 *figures in the text.*

The author remarks that, in preparing briquettes of peat and brown coal, no substance for binding the material together is needed. The application of sufficiently high mechanical pressure and the maintenance of a certain degree of humidity in the peat or brown coal are the sole indispensable conditions.

It is true that, in some brown coals, the contained bitumen serves to bind them together into briquettes, but the capabilities of the bitumen in this respect do not depend so much on the quantity of it that is present as on its chemical composition. Thus some brown coals poor in bitumen yield better compacted briquettes than others which are richer in bitumen.

In ordinary coal, the contained bitumen begins only to soften at temperatures above 392° Fahr., and even then the mechanical pressure necessary to compact the coal into briquettes just as it is, would be so enormous that the process would not pay.

The cementing-materials that have been longest in use in the manufacture of briquette-fuel are pitch, tar, and the allied substances. Briquettes prepared with pitch retain unimpaired for a considerable time, for many years indeed, their calorific properties. At the Imperial Dockyard at Wilhelmshafen it has been experimentally ascertained that such briquettes make less smoke in burning than the coal from which they are prepared. This may arise from the circumstance that their structure is evenly compact throughout.

Tar is a less satisfactory material for the purpose, even if saponified with alkalies by the Reinhold-Martin process.

In selecting other cementing-materials it is well to choose organic substances, as they help the combustion; while inorganic substances are in themselves incombustible, increase the waste in the form of ash, and take off

with them some of the heat. Many British patents have been taken out for the use of asphalt in this connection, but it is on the whole too costly, and can be better utilized in paving, etc.

A British patent of 1886 contemplated the application of petroleum to briquette-making, but other far from satisfactory substances were to be used with it, such as sulphuric acid and lime. Recently, a process has been patented in Galicia by Dr. Bernhard Diamand, embodying the utilization of petroleum-refuse in briquette-making, but for reasons which the author assigns, the process does not seem likely to meet with unmixed or universal approval.

Various other processes are described, and dismissed with faint praise, such as those in which the Jurassic *Posidonia* oil-shales of Reutlingen, after crushing and distillation, are used as the binding-material; or those in which the application of soot, starch, Carragheen moss, molasses, and cellulose finds a place. On the other hand, the utilization of sulphite-cellulose residues, a very troublesome variety of factory-waste, appears to the author fairly promising. Mr. Fiedler, Munich, proposes in this connection the use of the following mixture for briquette-fuel: 87 per cent. of coal-duff, 10 per cent. of sulphite-cellulose residues, 2 per cent. of blood, and 1 per cent. of lime. Blood is introduced here, because of its remarkable agglutinating properties. Derivatives of resin, albuminous substances, sawdust (from resinous timber) and even fæcal matter, have all been the subject of industrial experiment, and in some cases of patents.

The author then passes in review the various inorganic substances that have been proposed or used for cementing coal-dust into briquettes. In many cases these substances are intended to play a twofold part—that is, to accelerate combustion as well as to hold the stuff together; as, for example, the process wherein powdered clay, alum, and Chile saltpetre are mixed with the coal. Messrs. Dörr and Oidtmann propose to make use of the carbonaceous shales in pit-heaps by grinding them very fine, and then making them into briquettes with an admixture (if needful) of coal-dust, peat or sawdust, and a suitable binding-material. L. L. B.

SCHNABLEGGER COKING PROCESS FOR UTILIZING SAWDUST, PEAT, LIGNITE, ETC.

Schnablegger's Verfahren, Sägespäne, Torf, Lignit und Braunkohle zu verkoken. By F. Toldt. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1902, *vol. l., pages* 195-197, *with* 6 *illustrations in the text.*

The author has examined samples of coked sawdust, peat, lignite, etc., prepared by the Schnablegger process (the particulars of which are not divulged by the inventor), and finds that fusion has occurred in the oven, the coke of peat and lignite exhibiting a columnar structure and cauliflower surface. Certain adjuncts, which are said to be readily obtainable, are added to the material before the actual operation of coking is performed. The more finely divided the material and the lower the percentage of ash-constituents the better, so that sawdust forms the best material for producing a cheap coke by this process. The product appears suitable for all metallurgical uses, including blast-furnaces, and the process may therefore find profitable application in places where iron-smelters are short of fuel, although in the immediate vicinity of supplies of lignite. C. S.

COKE FROM NON-COKING COAL.

Note sur la Fabrication du Coke par le Procédé Hennebutte. By Marc Warolus. *Publications de la Société des Ingénieurs sortis de l'École Provinciale d'Industrie et des Mines du Hainaut*, 1902, *series* 3, *vol. xii., pages* 40-53.

Most coals when stacked deteriorate, and sometimes heat so as to ignite. Mr. Fayol found that this alteration is due to the oxidation of the coal, and not of the pyrites, as was generally supposed. By scientifically interpreting the results arrived at by Mr. Mahler, Mr. Hennebutte has succeeded in constituting the substance that is wanting in some coals for producing coke. Leaving out of the question anthracites and non-bituminous coals, it may be said that the effect of exposing coal to the air is to increase its weight, the action of heat acting as adjuvant within certain limits, while the increase of weight in bituminous coals sometimes attains 10 per cent. in a week. Mr. Mahler found that Commentry coal containing:—Carbon, 85·664 per cent.; hydrogen, 5·604 per cent.; and oxygen with nitrogen, 8·732 per cent., subjected to a heat of 248° Fahr. (120° Cent.) for a week in a drying stove, then contained:—Carbon, 72·652 per cent.; hydrogen, 3·347 per cent.; and oxygen with nitrogen, 23·911 per cent., while the calorific power had diminished by 20 per cent.

Chemists have long known that peats and lignites contain a special hydrocarbon only met with in coal in its normal state, and which on oxidizing gives rise to ulmic acid. Oxidated coals, those cropping out at the surface, coal-dust, etc., take on again to a certain extent the properties presented in past geological periods by the decomposing plants which formed them. By oxidation also coal loses its caking power; and by heating a coal from the Lens colliery to 212° Fahr. (100° Cent.) for a year Mr. Campredon reduced its caking capacity from 13 to 0. Accordingly the action of oxygen, by forming ulmic acid, at length entirely destroys the cementing substance of the coal.

Mr. Mahler concluded that the substance indispensable for the agglomeration of coke must be sought among the hydrocarbons susceptible of transformation into ulmic acid on contact with oxygen; and Mr. Hennebutte has succeeded in finding a hydrocarbon that combines the necessary properties. His investigations have shown that the caking power of a coal to be coked is a function of the quantity of nascent carbon or cementation-graphite produced by the dissociation of the hydrocarbons during its carbonization. The coals capable of yielding blast-furnace coke are those containing hydrocarbons that are dissociated at a high temperature, while depositing, on the coal being coked, graphite which cements the coal particles on the mass contracting.

Pitch, which leaves a coke as a residue of distillation, has not given successful results for coking poor coals, while the hydrocarbons give rise to a magma of graphitic crystals, which explains why pitch exerts no cementing effect. The compactness of coke is a function of the difference between the expansion-coefficient of coal while being coked and the contraction-coefficient of coke; or, in other words, the coke is so much the more compact as the contraction of the coal charged is greater. It follows that all coals, which contract on being carbonized, are capable of yielding blast-furnace coke, provided that the hydrocarbons, in which they are deficient, be added and thoroughly mixed with the coal.

It is this special hydrocarbon which Mr. Hennebutte produces under the name of "cement," and which is sent out in the form of an impalpable black powder or in the liquid state. His process is suitable for

all coke-ovens, without any modification being required; but one condition (not peculiar, however, to the Hennebutte method) is imperative, namely, that the cement be intimately mixed with the charged coal. This method of coking is moreover of general application, for it permits of coking lignites, non-bituminous coals, and also those burning with a long flame, the nature and percentage of the cement being the only variation.

At the Houssu collieries satisfactory trials were made with coals unsuitable for coking, and also with coking-coals that formerly received an enrichment which is now superseded by a fixed quantity of cement. At that time the company mixed from 10 to 20 per cent. of coal-dust from the Couchant de Mons district with its own coking-coals containing 15 per cent. of volatile matter and 12¼ per cent. of ash. Half the quantity received the addition of 3 per cent. of cement, increasing the volatile matter by 1 per cent.; and the other half, enriched by the coal-dust, had exactly the same percentage of volatile matter. The coke obtained in both cases was irreproachable, while the ash-content in the sample made with coal-dust was greater, as was necessarily the case, the dust showing 17 per cent. of ash while the cement contains none. Moreover the Hennebutte method gives 2·4 per cent. more coke, while the proportion of large coke is 2·63 per cent. greater.

The cement creates a high temperature, so that coals not rich in volatile matter may be coked. At the present time 30 per cent. of the coal charged contains only 14½ per cent. of volatile matter; and the proportion of cement does not exceed 2 per cent. of the charge. The improved yield more than pays for the cost of the cement; and, as regards carriage, coke-producers away from collieries will find a considerable saving, while they are unaffected by fluctuations in the market, as the cost of the cement scarcely varies.

J. W. P.

THE SELIGSOHN AMALGAMATION PROCESS.

An Improved Amalgamation Process. *By* A. Chester Beatty. *The Engineering and Mining Journal* [*New York*], 1901, *vol. lxxii., page* 108, *with* 1 *illustration in the text.*

The object of this process is to increase the percentage of gold-extraction by amalgamation, by passing ammoniated air, mixed with either chlorine or bromine, into wet ore-pulp. These gases are introduced as the pulp issues from a stamp-battery, Huntington mill, or other crushing machinery. The chemistry of the process is somewhat obscure, but the result in nearly all cases has been to effect a marked increase in the percentage of gold extracted by amalgamation. X. Y. Z.

THE HICKS GOLD-RECOVERY PROCESS.

The Dahlonega Consolidated Gold Mining Company's Plant. *By* Prof. Wilber Colvin. *The Engineering and Mining Journal* [*New York*], 1901, *vol. lxxii., page* 202, *with* 1 *illustration in the text.*

Much of the ore put through the mill was of a low grade, taken out in development-work. It is neither soft ore, nor distinctively sulphuret or hard ore; and it seems to be the most difficult of any from which to save the gold. Neither the plates, nor the concentrators catch it, and it washes over and is lost. Ore that assayed £1 13s. to £2 10s. (8 to 12 dollars) per ton yielded only 8s. 4d. to 12s. 6d. (2 to 3 dollars) per ton.

For several months tests have been made with the Hicks process. Essentially, it consists in subjecting the ore-pulp as it comes from the mill-stamps to a mercury bath, as it is agitated in a closed barrel at a certain temperature and with devices to keep the mercury from flouring. The experiments have been entirely successful, and ores from which the mill had been saving 8s. 4d. to 12s. 6d. (2 to 3 dollars) per ton yielded £2 6s. to £2 10s. (11 to 12 dollars) per ton under this process. X. Y. Z.

THE TREATMENT OF BATTERY-SLIMES BY FILTER-PRESSES.

Notes on the Treatment of Slimes by Filter-presses. By Clement Dixon. *Journal of the Chemical and Metallurgical Society of South Africa*, 1902, *vol. iii.*, *pages* 13-14.

Good work is now being done with the filter-press in Western Australia, New Zealand, and other places, where the decantation-process is not viewed with favour.

The 6 tons filter-press, made by Mr. Dehne, Halle-on-Saale, Germany, is an excellent machine, and will hold 6 tons of dry slimes and about 3 tons of moisture. As the press could be re-charged, say every 2 hours, each machine of this size has a capacity of from 60 to 70 tons of dry slimes in 24 hours.

In establishing the filter-press on a slimes-works, the most important detail is to find out by experiments what thickness of slimes-cake should be made, or, in other words, what is the best depth to make the hollow frames, so as to ensure that the cakes will be uniformly permeable to wash solutions; this thickness, of course, depends on the nature of the ore and the fissures of crushing. A cake, 3 inches thick, would probably be found suitable for the Rand.

There are two principal methods of dealing with slimes in filter-presses:— (1) The slimes (separated by spitzlutten, settled in **V** boxes and settling vats) are agitated with weak cyanide solution of the required strength; and, so soon as the solution of the gold is practically complete, the pulp is forced into the presses, so as to separate the gold-bearing solution from the slimes. Then weak-wash or water is forced through the cakes, so as to displace the remaining gold-bearing solution. (2) The solution of the gold may be effected in the filter-presses (without previous agitation) by charging the presses with slimes and then forcing cyanide solution through the slimes-cakes until the highest commercial extraction of the gold is obtained. Then displace the gold-solution by weak-wash or water.

Both these methods are in use in Western Australia, but the choice must be determined by experiment on the slimes to be treated. The first method is adopted with every success by the largest reduction-works in New Zealand. There is a certain accumulation of weak solution; but, in practice, it is not necessary to throw away much of any valuable solution. It may be used for washes on the sand-plant, as well as for washing the press-cakes, before they are thrown out. At the Waihi works in New Zealand, up to the end of June, 1902, the company had treated about 50,000 tons of slimes and had obtained an extraction of over 90 per cent. In New Zealand, the charges contain from 12 to 13 dwts. and the residues 1 dwt. or less. The bulk of the solution used is 1·5 to 1 per cent. The strength of solution used in New Zealand is 0·1 per cent.

The following figures, for 1901, were obtained on the Kalgoorlie goldfields, Western Australia:—

Name of Mine	Battery.			Sands.			Slimes.		
	Cost per Ton.		Yield of Bullion per Ton	Cost per Ton.		Yield of Bullion per Ton.	Cost per Ton.		Yield of Bullion per Ton.
	s.	d.	Dwts.	s.	d.	Dwts.	s.	d.	Dwts.
Lake View Consols ...	6	10·5	13·8	5	11·0	10·6	7	0·0	6·6
Ivanhoe Gold Corporation	6	8·0	11·5	5	2·8	1·5	6	7·3	8·1
Golden Horse-shoe Estate	9	7·7	14·9	6	2·3	10·7	10	1·4	8·8

J. W.

THE LEAD-SMELTING OF ZINC-GOLD SLIMES.

The Lead-smelting of Zinc-gold Slimes. *By* P. S. Tavener. *Journal of the Chemical and Metallurgical Society of South Africa.* 1902, *vol. iii., pages* 70-77, *and* 1 *plate.*

This process was introduced by the author in August, 1899, and since the resumption of milling at the Bonanza, Limited, Witwatersrand, some 14 months ago, it has been continuously in operation. The lead-smelting may be described as a scorification-assay conducted on a large scale, the zinc-slimes being melted and the gold recovered in lead-bullion. The lead-bullion is then cupelled or, to use a better term, refined.

In the clean-up, all the precipitate is at once pumped from the clean-up tub into the filter-press: the fine zinc which remains at the bottom of the tub being heaped up on one side and allowed to drain for about ½ hour, when it is ready for the smelting-room. The filter-press is cleaned out and the moist cakes are taken to the furnace where both slimes and fine zinc are put in separate trays into a drying oven, and warmed through for 15 minutes, the fine zinc being kept separate from the pressed slime.

In charging the furnace, the slime is first dealt with. After warming in the drying oven, it is at once rubbed through a sieve (4 holes to the linear inch), and then roughly weighed for fluxing, the necessary fluxes having been previously mixed. The flux is added to the slime and the whole passed through a sieve, to ensure thorough mixing, and then shovelled direct into the furnace. When all the filter-press slime is charged, the fine zinc is dealt with in the same way and put into the furnace on the top of the slime, in order to prevent loss by dusting, and also to have the greater portion of the litharge present on the top of the charge.

The fluxes used are:—Residue-assay slag and commercial litharge (the former is a bye-product from the assay-office and costs nothing).

The author has found that the following, with little variation, will give satisfactory fusion and clean slag:—Slag, 25 to 30 per cent., made up of 10 per cent. assay-slag, the balance being equal quantities of old slag and scalings from the pots of a previous smelt. Roughly, the proportions of fluxes are:—For slime, 100 parts by weight use litharge, 60 parts; assay-slag, 10 to 15 parts; slag previously used, 10 to 15 parts; and silica, 5 to 10 parts by weight. For fine zinc, 100 parts of weight, use litharge, 150 parts and slag 20 parts by weight. A few trials made on a small scale in assay-office fires would quickly show the best proportions to use.

The lead-bullion obtained should not contain more than 8 per cent., or at most 10 per cent., of fine gold.

As a reducing agent for the slime, 1 per cent. of sawdust on the weight of litharge is added, or, if more than 60 per cent. of litharge has been used, 1½ to 2 per cent. of sawdust is necessary.

The cupelling furnace is built with ordinary local fire-bricks: the blast being obtained by a Root blower, small size, driven at a speed of 1,600 revolutions a minute. J. W.

THE SMELTING AND REFINING OF ZINC-GOLD SLIMES.

The Smelting and Refining of Zinc-gold Slimes. *By* E. H. Johnson *and* W. A. Caldecott. *Journal of the Chemical and Metallurgical Society of South Africa*, 1902, *vol. iii., pages* 21-24.

An epoch of advance, in the above processes, dates from Mr. A. F. Crosse's statement in June, 1898, to this society, that he and Mr. E. H. Johnson had independently succeeded in producing pure bullion from the zinc-precipitate of the cyanide process. The point of similarity in the two methods was the use of manganese dioxide in the flux, and the points of divergence were the use by Mr. Crosse of a clay-lined crucible and silicate of soda; and by Mr. E. H. Johnson of a replaceable clay-liner to the crucible and sand as the source of silica. The zinc-gold slimes, having been efficiently treated by dilute sulphuric acid and thoroughly washed, are calcined at a fairly high temperature without any stirring of the dried slimes.

The following analysis, made recently by Mr. A. Whitby, of acid-treated and calcined slimes, illustrates the Rand product:—Gold, 34·50; silver, 4·75; lead, 12·50; copper, 2·55; ferric oxide, 3·65; zinc oxide, 7·00; sulphur trioxide, 6·95; nickel oxide, 1·00; silica, 21·00 per cent.; a total of 93·90 per cent., leaving the organic matter undetermined.

The following is a basis of flux, which the authors have used for some time, varying the proportions to suit special conditions:—To slimes, 100 parts: use fused borax, 20 to 35 parts; manganese dioxide, 20 to 40 parts; and sand, 15 to 40 parts. A little fluorspar may be added to assist fluidity.

At a recent smelting at the Robinson Deep mine, 202·8 pounds of calcined slimes yielded 1,016·1 troy ounces of fine gold in the total bullion. The bullion contained 970 gold and silver per 1,000 parts. The weight of slag produced was 286 pounds; it ran fluid and almost neutral, and contained 0·9 ounce of fine gold and 5·5 ounces of silver. J. W.

LOSSES OF SILVER IN CUPELLING.

The Losses of Silver in Cupelling with varying Amounts of Lead and Silver. *By* W. H. Kauffman. *The Engineering and Mining Journal* [*New York*], 1902, *vol. lxxiii., pages* 829-830.

A series of experiments were made to determine the losses sustained under the following conditions:—(1) With the same amounts of silver and varying amounts of lead; (2) with varying amounts of silver, from 25 to 200 milligrammes; (3) the influence of copper on the results; (4) the influence of varying temperatures; and (5) the influence of various grades of cupels. The apparatus and *modus operandi* of the experiments are described in the text and the results embodied in a table.

Some large variations in losses occur by difference of temperature, even where the conditions of cupellation are otherwise the same. Small differences of temperature cause surprising differences in the results, and an excessive heat will cause greater losses than any other variation in the conditions of cupellation. The following conclusions are drawn from the tabulated results of the experiments:—(1) The percentage-loss of silver is greater in cupelling small amounts of silver than when larger amounts are cupelled. (2) The loss is appreciably greater when the lead-button weighs 25 grammes than when it weighs but 5 grammes, except in the case of the 25 milligrammes silver-button. With 10 and 15 gramme buttons, the losses are generally smaller than with 25 gramme buttons, and larger than with 5 gramme buttons. (3) Similar conclusions are drawn regarding buttons containing small amounts of copper; the losses are not increased by the presence of copper up to 100 milligrammes. (4) With potash-and-borax cupels, the losses are in general the same as when water-cupels are used. (5) Excessive heat causes greater losses than large amounts of lead, and (6) the smallest losses occur when a small lead-button is cupelled at a low temperature. X. Y. Z.

ALUMINIUM-ZINC ALLOYS.

Aluminium-zinc Alloys. *By* Dr. Joseph W. Richards. *The Engineering and Mining Journal* [*New York*], 1901, *vol. lxxii., pages* 715-716.

Many contradictory statements having been made concerning these alloys, the writer lays it down, as a rule obtained from the experience of himself and others, that none of these alloys possess mechanically useful properties unless the aluminium-content exceed the zinc. All alloys containing from 1 to 10 parts of zinc with 1 part of aluminium may be classed as mechanically valueless. On the other hand, alloys containing more aluminium than zinc first commence to possess valuable properties.

The alloy of 2 parts of aluminium to 1 part of zinc is a remarkable alloy, being equal in strength to cast iron, it melts at about 800° Fahr., does not readily oxidize, takes a fine finish, and perfectly fills the joints of the mould: it is, like cast-iron, brittle, but resists corrosion well. At present, however, there is no difficulty in reaching a tensile strength of 40,000 pounds in castings. In its characteristics, it closely resembles a high-carbon steel, being very rigid, slightly elastic, and breaking short with a fine-grained fracture. It works well under the tools, in turning or boring, not requiring lubrication. It is the hardest and strongest of the available alloys of these metals, takes a high polish and keeps its colour very well. Its specific gravity is 3·8, and calculation shows the remarkable contraction of 17 per cent. during the alloying, which suggests the cause of its great strength. Numerous uses for such an alloy will suggest themselves to every mechanical engineer.

The alloy of 3 parts of aluminium to 1 part of zinc is the most generally useful of all the aluminium-zinc alloys. Remarkably clean and sharp castings can be made with it, and when properly made from pure metals it is all that could be desired in its working qualities, being equal to the finest brass in the lathe, under the drill, and in not clogging the file. It casts sound, takes a high polish, and has as fine a colour as the best aluminium. It is not so hard and short, nor quite so strong as the 33 per

cent. zinc alloy, but has superseded it for most purposes because of its better working qualities and greater reliability under shock. It is non-magnetic, and therefore particularly useful in the manufacture of scientific instruments.

Below 25 per cent. of zinc, the strength and hardness of the alloys decrease rapidly, and at 15 per cent. the alloy can be forged, rolled or drawn. Mechanical tests of this latter alloy after working have not yet been made. X. Y. Z.

ALLOYS AS SOLUTIONS.

Alloys as Solutions. *By* John Alexander Matthews. *The Engineering and Mining Journal* [*New York*], 1901, *vol. lxxii., pages* 819-822 *and* 851-854, *with* 15 *illustrations in the text.*

This paper is valuable, as furnishing a concise account of the present position and prospects of alloys research. The author states that it is truly remarkable that any class of substances so long known and studied as alloys should have so completely hidden the secrets of their inner molecular constitution until within the last decade or so. The causes of the rapid advance in this direction during the last few years are principally found in our increased knowledge of solutions, the development of metallography, and in the improvements of pyrometry. The writer deals very fully with the resemblance between alloys and solutions.

It is remarked that text-books of physical chemistry contain much information about the solution of gases in liquids, liquids in liquids, and solids in liquids, but are for the most part silent on the subject of the solution of solids in solids. Nevertheless, it is this conception of alloys as solutions (solid solutions) that has been steadily progressing in favour during recent years. This position is explained and substantiated by an account of the experimental results obtained by many recent investigators. Because certain bodies are called solid, it is not implied thereby that molecular mobility is entirely absent; the difference in mobility of the molecules in solids and those in liquids is one of degree only. Metals in the so-called solid state tend to evaporate, and metals in the same state unquestionably diffuse into each other. The investigation of recent years has demonstrated many points of resemblance between metallic mixtures and ordinary solutions:—One metal diffuses into another like a salt into water; like two liquids, they may be perfectly mixable or form layers; the layers are not pure, but each contains a little of the other in solution; and in general, the solubility increases with the temperatures; the metals flow under pressure; they may or may not react chemically when brought into intimate association; the molecular mobility increases with the temperature; the phenomena observed on the cooling of binary alloys strongly suggest the phenomena observed on the freezing of salt solutions; the depression of the freezing-point of one metal when another is added follows the laws of Coppet and Raoult; and, in fact, to point out all the similarities between alloys and ordinary solutions would be to give our present conception of the constitution of alloys.

The great value of this conception of alloys as solutions is that it enables the process of the production of alloys to be directed along definite lines determined by intelligible principles. The production of alloys in the past has been by the very wasteful method of chance, but the writer now

hopes to see it develop into an exact science. Indeed, many of the illustrations furnished in the text are purely mathematical figures. One of these is a cooling-curve drawn to the co-ordinates of time and temperature. During the cooling of a molten alloy, various constituents may crystallize out successively; definite compounds stable at high temperatures may split up as the temperature falls, or new compounds impossible at high temperatures may be formed at lower temperatures. All such molecular changes are accompanied by corresponding thermal effects, such as the liberation or absorption of heat. By accurate measurement of the temperatures at those points most valuable information is obtained in regard to the molecular movements in the mass. This information is obtained by means of the cooling-curve. Then, again, in many pairs of metals, the relative solubility is a function of the temperature, from which it appears likely that at some particular temperature solubility is complete. This particular temperature is found by a critical curve, illustrated and described in the text.

The freezing-point curve is a third mathematical drawing capable of rendering great service in alloys research, and it depends on the principle that the freezing-points of metals follow laws well known in connection with fluids. The depression of the freezing-point of one metal when another is added follows the laws of Coppet and Raoult, namely:—(1) For moderate concentration the fall of freezing-point is proportional to the weight of dissolved substance present in a constant weight of solvent; and (2) when the falls produced in the same solvent by different metals are compared, it is found that a molecular weight of a dissolved metal produces the same fall whatever the metal may be. Now, the cooling-curve, above mentioned, results during the cooling of a single alloy, the co-ordinates being time and temperature. When a series of such curves are obtained for any pair of metals mixed in all proportions from 0 to 100 per cent. of one in 100 to 0 per cent. of the other, and the critical points are plotted in a diagram whose co-ordinates are temperature and composition, we get what is known as a freezing-point curve. That is, the points at which all possible combinations of the two metals freeze are indicated more or less accurately: the accuracy of the whole curve being greater or less as the number of points on the curve actually determined is greater or less.

After describing the uses of these various curves, the writer concludes by remarking that when many sets of complete freezing-point curves have been determined, and the alloys of the series have been examined metallographically, and when the ordinary physical tests have been accurately applied to them, we may then be able to generalize and to predict properties of new pairs of metals as well as to set out intelligently to produce new and useful alloys. X. Y. Z.

CEMENT MADE FROM BLAST-FURNACE SLAG.

Die Verarbeitung von Schlacken auf Zement. By Dr. — Steger. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate,* 1903, *vol. li., Abhandlungen, pages* 65-71, *with* 3 *figures in the text.*

Certain calcareous blast-furnace slags, especially at these works where raw pig-iron is produced, approximate in their composition to that of Portland cement; and to become exactly identical with it in composition they need only to be supplemented, according to circumstances, by certain proportions of limestone, clay, or aluminous substances such as bauxite.

The mixture of slag, etc., is ground very fine, well mixed together, moistened sufficiently to be made up into bricks, and then burnt. Actual melting does not take place, as the proportion of lime is calculated to prevent this. The calcined bricks are pulverized, and yield a Portland cement of unexceptional quality.

But the hardness of the slag makes grinding a costly process, sufficiently so in some cases to prevent the method just decribed from being, economically speaking, workable. Another system has been suggested: the molten slag fresh tapped from the furnace, is to be mixed at once with the necessary proportions of pulverized limestone or clay, well stirred up, and converted direct into cement. The fundamental objection appears to be that the consequent reduction of temperature of the whole mass is too rapid to permit of uniformly satisfactory results.

Slag-cements are now usually prepared as follows:—The slag flowing out of the blast-furnace is led into water kept as cold as possible, and breaks up consequently into a multitude of small grains. This granular slag is scooped up out of the cooling-pond by appropriate apparatus and conveyed thence to driers, where it is freed from water (the percentage of which is generally as high as 60). This drying process is fairly difficult and costly. The slag is then ground to a fine flour, and mixed with previously slacked lime into what is (to all intents and purposes) ordinary cement. A little moistening with water is sufficient to harden it gradually into a solid body.

In order to avoid the difficulties of the drying process above described, one method is, by means of blowing air through the molten slag, to convert it into slag-wool. This reduces the cost of grinding and moreover induces by oxidation certain chemical changes in the slag which are not without influence on its hydraulic qualities. The sharp, angular slag-dust is very dangerous to the respiratory organs of the workmen, and therefore all the apparatus has to be so planned as to work without spreading dust in the surrounding atmosphere.

The chief impurity present in slag, of which it is desirable to get rid when converting the slag into cement, is sulphur, and the author describes briefly the process by which the sulphur is finally eliminated in the form of gypsum.

One of the most recent advances made in the manufacture of slag-cement, consists in dispensing with any substances beyond the slag itself, by treating the molten mass, conveyed into appropriate recipients, with atmospheric air. A description, with explanatory figures, of the new process is given. It is interesting to note that while Portland cement contains from 57 to 66 parts of lime by weight, the air-treated slag only contains from 40 to 48 such parts, and the modern theory is that cement may safely contain a far smaller proportion of lime than has been hitherto thought indispensable.

The recent successful use of rotating furnaces in making ordinary Portland cement has suggested the burning of a mixture of highly basic slag (which soon crumbles to dust when exposed to the atmosphere) with powdered limestone or quicklime, in a rotating furnace. In this way a cement is cheaply obtained, which can be used without further preparation. L. L. B.

BOILER-ACCIDENTS IN FRANCE IN 1900 AND 1901.

(1) *Bulletin des Accidents d'Appareils à Vapeur survenus pendant l'Année 1900.* Anon. *Annales des Mines*, 1901, *series* 9, *vol. xx.*, *pages* 548-562, *and* 2 *plates*.

In 1900, 31 boiler-accidents took place in France, resulting in the deaths of 15 persons and more or less serious injury to 31 others.

The only one of these accidents that took place in a mine or quarry was that which occurred at the Escarpelle colliery, Nord. On April 7th, 1900, a copper waste-pipe, which was in an unsound condition, burst over a length of 14 inches, in the part which lay between the generator and the waste stopcock. The water, spirting out of the ruptured tube into the rear portion of the furnace, determined a sudden rush of flame which scorched badly the stoker.

Out of the total number of 31 accidents referred to, 14 took place in water-tube boilers and these account for 7 out of the total of 15 deaths. In the attribution of causes, 5 accidents are set down to defective installation, 14 to defective maintenance, 13 to bad usage and 4 undetermined. As this accounts for 36 instead of 31 cases, the inference is that in 5 instances two causes combined to produce the accident. Four accidents occurred in railway or tramway-locomotives, and three on steamboats.

(2) *Bulletin des Accidents d'Appareils à Vapeur survenus pendant l'Année 1901.* Anon. *Annales des Mines*, 1902, *series* 10, *vol. ii.*, *pages* 550-564, *and* 5 *plates*.

Of the 36 boiler-accidents which were recorded in France during 1901, 3 took place in coal-mines.

At Ferfay colliery, Pas de Calais, on May 2nd, 1901, a horizontal boiler fed with pit-water (which is in this colliery highly charged, at times, with saline matter) suddenly exploded, blowing the furnace-doors open, and scalding the stoker to death. The accident was caused by a rent in the boiler-plates, which had got superheated in certain parts, as a consequence of the deposition within them of a thick crust of sodium chloride and calcium sulphate.

At Aniche collieries, Nord, on July 19th, 1901, an accident occurred in No. 4 of a battery of four cylindrical horizontal boilers. No. 4 boiler was being cleaned, and in order to cool the atmosphere within it cold water was injected by opening the feed-valve. No. 1 boiler was being fired: its feed-valve also was open, and there was only the stop-valve to prevent a rush of boiling water thence into No. 4. Unfortunately this stop-valve failed to perform its work, and boiling water poured into No. 4 upon the luckless workmen who were busy cleaning the boiler. Three were badly scalded, and one more slightly so. The failure of the stop-valve would have had no disastrous results, if the workmen had been ordered out before proceeding to turn on the feed-water.

At Prades-Nieigles colliery, Ardèche, a boiler burst on September 9th, 1901, and 2 workmen sustained slight injuries in making their escape. The boiler (horizontal, cylindrical, of the reversed-flame type) was in a very bad condition. It was fed with very acid water taken from a brook, into which flowed the pit-waters from a highly-pyritous coal-mine. Hence, such excessive corrosion of the boiler-plates that leakages were frequent, and finally a tremendous rent was opened up in them on the date mentioned.

Apart from coal-mines, boiler-explosions took place in 6 railway-locomotives, in 6 steamboats (fatalities more numerous in these than in any

other class of accident), in 4 weaving and spinning sheds, and the remainder in various mills, factories, power-stations, etc.

The total number of lives lost was 27, and of persons seriously injured 35. The boilers which burst were in 11 cases non-tubular, in 14 cases provided with smoke-tubes, and in 7 cases with water-tubes.

No less than 19 of the accidents are attributed to the bad state of repair of the boilers, 6 are attributed to original defects of installation, 12 to misuse (in various degrees) of the boilers, and in 3 cases the blame cannot be definitely apportioned. L. L. B.

EXPERIMENTS WITH CENTRAL CONDENSING-PLANT AT COLLIERIES.

Versuche und Beobachtungen an Centralkondensationen auf Steinkohlenzechen. By Ernst Stach. *Glückauf*, 1902, *vol. xxxviii., pages* 277-289, *and* 3 *plates.*

Exhaustive experiments were made at Dorstfeld, the Graf Schwerin and Herne collieries, with central condensers constructed by the Maschinenfabrik Grevenbroich, Messrs. Balcke & Company and Messrs. L. Schwarz & Company, respectively. The results are considered to shew that, in all cases, a considerable saving of fuel is effected by this kind of plant. The actual power consumed by the condensing plant may be economized by adapting the working of the circulation-pump to the load; and it is advisable to employ two pumps that can be worked together or separately as required. Too much stress is generally laid on a high vacuum, with the result that the plant is usually larger than is really necessary, although a large air-pump is rather an advantage than otherwise.

The amount of water required for cooling may be calculated by the formula: $n = (607 - 0{\cdot}7t') / (t - t_0)$, in which n represents the factor to be multiplied by the weight of steam to give the weight of water needed; t' is the temperature of the steam to be condensed; t, that of the effluent cooling water, and t_0, the initial temperature of the latter. A 90 per cent. vacuum corresponds to a steam-temperature of about 115° Fahr. (46° Cent.) and an 80 per cent. vacuum to about 140° Fahr. (60° Cent.). Assuming that the temperature of the effluent water is 2° Cent. lower than that of the steam, and that the temperature cannot be reduced below 30° Cent. in warm, damp weather, then the value of n will be, for a 90 per cent. vacuum, 41, and for an 80 per cent. vacuum, 20. Hence, in order to obtain an increase of 10 per cent. in the vacuum, the water-pump must do 105 per cent. more work, the result being that the power consumed by the plant is increased from about 3 per cent. of the total efficiency to $4\frac{1}{2}$ per cent., which means higher working expenses, in addition to the greater prime cost. Moreover, with a lower vacuum, the condensed water has a higher temperature for return to the boiler, while the increased consumption of steam is unimportant when high admission-pressures (6 to 10 atmospheres) are employed.

In some cases, the mistake is made of omitting to connect old or distant engines to the central condenser. This should always be done, since the outlay on repairs will soon be repaid by the improved efficiency of the whole installation. Another reason for being satisfied with a lower vacuum is that for three-quarters of the year the lower temperature of the cooling water enables a higher vacuum to be readily obtained, and thus the average for the year is raised. C. S.

SUPERHEAT OF STEAM.

Wie hoch soll der Dampf überhitzt werden, um einen minimalen Dampf- und Heizmaterialverbrauch bei den Dampfmaschinen zu erzielen. By Josef Jedlička. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1901, *vol. xlix., page* 52.

The data given respecting the consumption of steam, feed-water and heat with saturated steam, are calculated without taking count of the priming in the steam. According to the type of boiler used, and the evaporation, the priming may vary from 3 to 12 per cent. of the total feed-water. The heat of liquefaction required to maintain this condition is wasted, and can only be partly recovered by collecting the priming water, and using it to feed the boiler. For this reason the values showing the increased economy of steam with a given degree of superheat, as against saturated steam, should be higher, and the co-efficients of heat lower than those given in the tables. The consumption of steam, feed-water and heat are also calculated without reference to the lesser specific weight of superheated steam, which depends on the temperature of superheat. If this circumstance be taken into account, the actual minimum values will be about 8 per cent. less than those given in the tables, because at constant pressure the specific weights are in inverse proportion to the absolute temperatures.

In a single-cylindered steam-jacketted condensing engine of 50 indicated horsepower, working with steam at a pressure of 8 atmospheres and superheated to 477° Fahr., the economy obtained would be 8·2 per cent., the consumption of steam 10·3 pounds and of feed-water 10·5 pounds per indicated horsepower-hour. For such an engine, the writer shows in tabular form the consumption of feed-water at varying powers and pressures, working with and without a steam-jacket, condensing and non-condensing. The co-efficients of heat given in the former tables are 1·25 times higher than they would be, if the above conditions are taken into account. In a three-cylindered condensing steam-engine of 1,000 horsepower, working at a pressure of 12 atmospheres, and the steam superheated to 486° Fahr., this co-efficient would be 21 per cent. The smaller specific weight of the steam has little effect on the temperature of superheat. E. M. D.

A HIGH-VOLTAGE TRANSMISSION-PLANT.

The 50,000 Volt Transmission-plant of the Missouri River Power Company. By W. G. McConnon. *The Engineering and Mining Journal* [*New York*], 1902, *vol. lxxiii., pages* 789-790, *with* 7 *illustrations in the text.*

The power-house of the Missouri River Power Company is located at Cañon Ferry, a little town at the mouth of Blackrock cañon, on the Missouri river, about 20 miles nearly due east of Helena, Montana.

A dam about 480 feet long, and designed to give a 30 feet head of water, has been thrown across the river at the mouth of the cañon. The amount of water in the river at this point is estimated to develop 10,000 horsepower all the year round. The work was begun 4 years ago, but considerable extensions were initiated in the fall of 1900. The power-plant now consists of ten direct-connected generators of 750 kilowatts of the three-phase type, with four exciters, of which two are machines of 90 kilowatts direct-connected to separate wheels, one a machine of 225 kilowatts with

a separate wheel, and one motor-driven generator of 115 kilowatts. The water-wheels are horizontal McCormack wheels, 45 inches in diameter, and each wheel has its own governor, seven being Lombard, and three Replogle governors.

The feature distinguishing this from all other transmission plants is the high pressure of 50,000 volts employed on the new lines to Butte. The distance by pole-line to Butte is 65 miles. The line itself consists of two lines of poles about 50 feet apart. Each line consists of three seven-strand copper cables arranged in an equilateral triangle with a spacing of 78 inches between the centres. These cables are transposed five times between Cañon Ferry and Butte. The average distance between the poles is 110 feet. It has been found, after exhaustive tests, that a thoroughly dry oak pin of the length used in this installation, boiled in paraffin, will readily hold up alone under 50,000 volts. A glass sleeve below the insulator is used to keep as great a length as possible of the pin dry under all conditions of weather.

The transformers at each end of the line consist of six oil-insulated transformers of 950 kilowatts with water-cooling coils in the cases. Those at Cañon Ferry transform from 550 to 50,000 volts, and at Butte, the step-down transformer is made from 50,000 to 2,200 volts. It is noteworthy that since the starting of the plant, there has been no mishap of any kind to the line of apparatus. X. Y. Z.

ELECTRIC POWER IN CALIFORNIA.

Electric Power-plants in the Mining Districts of Northern California. By G. P. Grimsley. *The Engineering and Mining Journal* [*New York*], 1901, *vol. lxxii., pages* 270-271, 300-301 *and* 330, *with* 2 *maps and* 5 *illustrations in the text.*

One of the most notable plants described by the writer is that now nearly completed by the Standard Electric Company.

The water-storage basins, including a natural rock-basin on Bear river below the Blue Lakes, have a capacity of 9,500,000,000 gallons. The water runs from this lake to the Mokelumne river, which flows over a granite bed, and in a deep granite-cañon which also carries the water from the upper lakes to the old Amador canal. This canal has a capacity of 3,000 miner's inches of water controlled by 82 flumes, and with a grade of 8 feet to the mile, giving a velocity of 300 feet per minute. A new ditch has been constructed with a capacity of 7,500 miner's inches and with 3 miles of flumes, some of which are 80 feet above ground-level. A large storage-reservoir has been built above the power-house, with a capacity sufficient to run the plant for 10 days. This will be used in case of breakage in the pipe-lines, and may be utilized in carrying peak-loads at certain times of the day. The new ditch connects by a branch with the reservoir, and also runs direct to the power-house with a fall of 1,482 feet. The old ditch too connects with the reservoir and power-house.

The power-house will have an equipment of seven Stanley generators of 3,000 kilowatts connected with seven impulse water-wheels of the Pelton type. The current is conducted into the transformer-room of the building, where the initial voltage of 2,200 will be stepped up to 60,000. The wires then pass to a separate building equipped with lightning-arresters, and out on the lines to Stockton, Oakland, San José, and the smaller towns along

the way. The line to San José will be continued around the bay to San Francisco, and will have a total length of 150 miles. This will be the longest operating transmission-line in the world, carrying the highest voltage, and acquiring power under one of the highest heads of water.

Storage batteries at Oakland, San José and San Francisco will carry the load in case of temporary shut-down of the plant, and will carry peak-loads as well as regulate the current on the entire system. The plant when completed next fall will have a capacity of 20,000 horsepower, and will cost about £1,200,000 (5,000,000 dollars). By building dams in Alpine county across Cold creek, Deer valley and Little Bear river, the capacity may be increased to 35,000 horsepower. When the plant is completed, electric power will be used in most of the mines in this district.

A number of other plants are described by the writer, and the appended maps are very useful, as showing the magnitude of the undertakings, and their probably far-reaching effects on mining development in Northern California. X. Y. Z.

AN ELECTRIC WINDING-ENGINE.

Ueber ein neues System elektrischer Schacht-Fördermaschinen. By Hans Bansen. *Glückauf*, 1902, *vol. xxxviii., pages* 175-177, *with* 1 *figure in the text.*

In the electric winding-engine introduced by the Union Elektrizitäts-Gesellschaft, Berlin, the usual resistances for altering the speed of the motor are replaced by a dynamo which can be caused to work in conjunction with or against the motor. A continuous current of, say, 110 volts actuates the winding motor, and also excites the field of the supplementary machine, the intensity in the latter case being variable between 0 and 110 volts by means of resistances. As the supply of current to the supplementary machine can be reversed, the tension may be varied between + 110 volts and − 110 volts.

In starting to wind the cage, the tension in the secondary machine is in maximum opposition to that of the winding motor, which therefore remains at rest, but as the opposing tension is gradually reduced by the starting rheostat, the winding motor begins to run at progressively increasing speed until the full tension is reached in the latter. The supplementary machine may then be short-circuited, or else employed to assist the winding motor and increase the tension to a maximum of 220 volts. To reduce speed, a shunt-regulating resistance reverses the current in the supplementary machine, whereupon the winding motor acts as a dynamo and sends an opposing current into the line-circuit, its speed being correspondingly reduced. During the short interval occupied in overcoming the force of inertia due to the higher speed, the winding motor acts as a primary machine and supplies, through the supplementary machine, a current opposing that of the line. In this way all waste of the line-current during alterations of speed is precluded. C. S.

ELECTRIC PUMPING-PLANT AT THE FIRMINY COLLIERY.

Installation électrique d'Épuisement au Puits Monterrad No. 2: Division de la Malafolie des Mines de Firminy. By — Denogent. *Comptes-rendus mensuels des Réunions de la Société de l'Industrie Minérale*, 1903, *pages* 61-62.

The pump is of the Jandin normal horizontal type; and electric driving was adopted, on account of its simplicity and the relatively slight cost of the plant.

When the pump makes 100 revolutions per minute, the motor gives out 182 horsepower; and under this load the efficiency of the motor is 94 per cent. The leakage in the conductor is 2½ per cent.; and the efficiency of the alternator is 90 per cent. with, and 92·5 per cent. without, the exciter; so that the total yield of the electric plant is (0·94 × 0·975 × 0·9 =) 0·825.

Long-continued trials at various times have given the following mean results:—Mechanical yield of the pump, 87 per cent.; volumetric yield of pump, 94 to 97 per cent.; loss of load in the delivery-pipe, 3 per cent.; and the total efficiency, or the ratio between the indicated power of the steam-engine and the work in the water raised, 60·6 per cent. The total efficiency is, however, 63 per cent. if the power absorbed by the centrifugal pump for condensation be deducted; and the consumption of steam per horsepower per hour in the water raised is 32 pounds (14·6 kilogrammes).

The total cost of the plant was about £14,000 (350,000 francs).

J. W. P.

ELECTRIC PUMPING-PLANT AT THE PORTES COLLIERY.

Installation électrique des Mines de Portes. *By* — Lecamus. *Comptes-rendus mensuels des Réunions de la Société de l'Industrie Minérale*, 1903, *pages* 4-10, *and* 3 *plates*.

The electric generating-station comprises a single-cylinder condensing Collman engine of 150 horsepower, driving a Siemens-Halske flywheel alternator. In this engine the distribution-valves, actuated by eccentrics, are constructed and arranged so as to avoid shock when they come down upon their seats, without, however, wire-drawing the steam, while at the same time effecting a rapid closing, due to a special cataract. The closing, however, slackens as the valve approaches its seat.

The three-phase alternating current is produced at a tension of 1,000 volts; and the alternator can give out normally 110 kilowatts. There is also a static transformer of 3 kilowatts supplying a current of 120 volts to a motor of 4 horsepower, driving a Rateau centrifugal pump, which raises the condensation-water to the top of a refrigerator.

The line connecting the station on the surface with the underground motor is a cable of three parallel conductors of 35 square millimetres section, covered with lead and armoured with steel wires.

The pump is driven, through an elastic coupling, by an asynchronous motor with a revolving field, the inductor being fixed and the armature movable. The reduction of speed is obtained by steel pinions and cast-iron spur-wheels with helical teeth. The suction and delivery-valves of the pump are in two stages, with a rise of ⅜ inch (1 centimetre). The underground pump raises 24,200 gallons (110 cubic metres) per hour to a height of 656 feet (200 metres), showing with its motor an efficiency of 79 per cent., and the cost of the kilowatt-hour is not 3 farthings (0·073 franc).

The centrifugal pump, which has worked since September, 1901, raises 17,600 gallons (80 cubic metres) per hour to a height of 393 feet (120 metres), taking into account both suction and loss of load. It consists of seven revolving wheels mounted on the same shaft and connected in series, so as to be traversed by the same current of water, the pressure increasing from one wheel to another, and each giving a fraction of height equal to the total height divided by the number of wheels. The efficiency of the centrifugal pump and its electric motor is 60 per cent., less by nearly

30 per cent. than that of the plunger-pump and its motor; but the maintenance of the former is insignificant, while for the latter there is the expense of lubricating and repairs, and also that of at least one man. In addition to this, the space occupied by the centrifugal pump is very small, being 8·5 feet (2·6 metres) long, 3 feet (90 centimetres) wide, and 2·6 feet (80 centimetres) high, while no foundations are required: as compared with which the plunger-pump requires a large underground engine-room, and strong foundations. J. W. P.

ELECTRIC PLANT AT THE COKE-OVENS OF THE ORLAU-LAZY MINES, AUSTRIAN SILESIA.

Die elektrische Anlage in der Cokesanstalt des Steinkohlenbergbaues Orlau-Lazy in Oesterr.-Schlesien. By Armin Hartmann. *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*, 1901, *vol. xlix., pages* 235-240, *with* 5 *illustrations in the text and* 1 *plate.*

At the coke-oven plant at Orlau-Lazy colliery, electric transmission has lately been introduced, and the results obtained are highly satisfactory. The motive power is steam furnished by 10 boilers, each with a heating surface of 1,150 square feet and a pressure above the atmosphere of 147 pounds. The boilers also serve the distillery where sulphate of ammonia and liquid ammonia are produced, and the benzol-factory. The works are spread over so large an area that a high-pressure electric current is required for power, and a low-pressure current for lighting. The reversed-current system has therefore been adopted, with a tension of 330 volts at the central station, for the coke-oven plant, and 3,000 volts at the outlying stations. For the incandescent light, a secondary current of 100 volts is provided.

At the central station, there are three dynamos coupled direct to compound condensing steam-engines, which run at 145 revolutions per minute. The engines have piston valve-gear, and sensitive tangential governors.

The coal is delivered in pieces cubing 4 inches, and is washed and sorted in jigger-screens, and the slate separated. It is then conveyed through an electrically-driven centrifugal pump to three enormous hoppers. The water is here drained off, and the coal carried to an electrically-driven disintegrator, where it is crushed, and passes thence to a storage-tower and the coke-ovens. By means of transmission-gear a 200 horsepower engine placed at a height of 62 feet above the ground drives the jigger-screens, the air-blast for the water, two elevators to carry away the slate, and the centrifugal pump. The disintegrator, an endless belt to convey the coal to it, and the elevator for the washed coke, are driven by another engine of 100 horsepower. The water which runs from the draining hoppers, being charged with coal-dust, is collected in a sump, and the coal which settles at the bottom is raised by a centrifugal pump in the basement, and returned to the main storage.

The coke is discharged from the ovens by a machine driven direct from the dynamos. By means of a cogwheel and rack, the ram is pushed forward at a speed of 22 feet per minute, and carries the coke with it. The machine may also be moved forward, by throwing the lever working the ram out of gear, and bringing another into play which forms the axle of the wheels of the machine.

The gases of the coke-ovens are exhausted by two electrically-driven

exhausters, and burnt under the boilers, after they have been washed, and the tar and ammonia recovered. Two motors of 50 horsepower in the boiler-house drive the feed-water pumps, and the pumps for the condensation-water. There are also two electric motors in the workshops for driving the mechanical tools, and a coke-separator.

A similar electric-transmission-plant is about to be installed at Karwin, but the waste-gases of the coke-ovens will be utilized to drive large gas-engines by direct combustion. E. M. D.

ELECTRICAL PROGRESS IN MINING AND METALLURGY.

Electricity in Mining. *By* GEORGE H. GIBSON. *The Engineering and Mining Journal* [*New York*], 1902, *vol. lxxiii., pages* 307-309, *with* 8 *illustrations in the text.*

Electric machinery was first introduced into the Cripple Creek district in 1888, and it was soon found to be more profitable for the individual mine-owners to rent motors and power from electric-power companies. The power plant of one of these companies is situated at Canyon City, and the current is transmitted 27 miles to Cripple Creek, driving crushing machinery, hoists, air-compressors, pumps, etc. The miner goes to work in an electric car, descends the mine in an electric hoist, drains his mine with an electric pump, works by the electric light, runs drills operated by electric motor-driven air-compressors (in some cases now being replaced by direct electric drills) and fires his shots by electricity. Within an area of 6 square miles, this district contains gold-mines whose production in 1900 amounted to nearly £4,500,000 (22,500,000 dollars).

The Trade-dollar Mining Company, of Silver City, Idaho, has recently erected a larger water-power plant at Swan Falls on the Snake river, from which power is transmitted to their mine 27 miles distant. The generators are operated from a jack-shaft driven by four vertical turbines. The alternators deliver three-phase current at 500 volts, which is stepped up to 22,000 volts for transmission.

The Golden Gate cyanide gold-reduction plant is supplied with electric power from a plant at Provo, Utah, 30 miles distant; the transmission is at 35,000 volts.

Electric power is very extensively used in coal-mines for hauling, hoisting, ventilating, pumping and lighting. The Keeling mine, near Pittsburg, has lately substituted, for rope-haulage, a haulage by electric locomotives. The Berwind-White Company, having a present daily output of 5,000 tons, do all their haulage entirely by electricity. The thing which strikes an English reader most forcibly is the steady manner in which rope-haulage is being superseded by the electric locomotive in American mines.

X. Y. Z.

WATER-SUPPLY AND GOLD-PLACERS OF SONORA, MEXICO.

The Upland Placers of La Cienega, Sonora, Mexico. *By* ROBERT T. HILL. *The Engineering and Mining Journal* [*New York*], 1902, *vol. lxxiii., pages* 132-134, *with* 7 *illustrations in the text.*

In May, 1901, the writer was requested to examine certain auriferous deposits in the vicinity of Cienega, district of Altar, Sonora, Mexico, which, in some respects may be described as a diminutive American Kalgoorlie.

Northwestern Sonora is a dreary desert-country. A few rivers drain the western slopes of the Sierra Madre, and attain considerable volume in their upper waters, but they gradually decrease in copiousness, until most of them sink into the desert-wastes before reaching the Pacific Ocean, except in times of extreme flood.

The writer's duty at Cienega was to make a preliminary report upon the gold-dirt, and to ascertain whether there was any feasible method of recovering it. Thorough samplings readily demonstrated the great richness of the ground, but, the existence of the gold being apparent, the important problem was to ascertain whether there was any manner of applying water to the recovery of this gold, and herein came the application of an interesting study of the question of underground water. The writer believes himself to have been the first to advocate some 12 years ago the principle that in the desert-region of arid America, the underground conditions are favourable for the collection of water in the loose detritus filling the desert-valleys, rather than in the impervious mountain-rocks which crop out around the rims of the deserts and lie beneath them as a floor.

In the vicinity of Cienega, there are three large desert-basins, and each indicates a supply of underground water which, properly conserved and applied, should save much of the gold of the rich placer-deposits. The smallest of these deserts is that in which the village of Sonora itself is situated, and here the most apparent evidence of considerable stores of underground water was manifested by the Cienega itself, from which the village takes its name. This is nothing more nor less than a point in the lowest part of the basin, where the ground-water comes out at the surface. Wells in the village strike this water at a depth of about 8 feet. The water is in considerable quantities, and a small stamp-mill has been run for many years in the village. A low chain of hills separates Cienega from a still larger basin, some 10 miles in cross-section to the northward, and an arroyo leads into this larger basin through the chain of Cienega hills from a still larger basin to the southeast. In the bottom of this arroyo are two wells. One was in constant use to run a small stamp-mill to which ore is brought from the mountains, some 10 miles distant. The other was constructed for the Mina Colorado, 9 miles north of the well and some 300 feet higher in altitude. It has since been abandoned, owing to the exhaustion of the mine.

On the writer's recommendation, this well was deepened from 15 feet, where the water was first encountered, to 57 feet, and two large pumps cannot exhaust it. It is estimated that this well yields about 326 gallons per minute, and the water flows in with increasing quantity with each foot gained in depth. With this water, the company now has an abundant supply to fill ponds for working the ground by the dredge-process, or even for fluming on a small scale. The probabilities are that this water-supply can be largely increased by other wells judiciously located. X. Y. Z.

ELECTRIC COAL-LOADING PLANT.

Nouvel Appareil d'Embarquement des Charbons aux Mines de Dourges. By — Prudhomme. *Comptes-rendus mensuels des Réunions de la Société de l'Industrie Minérale*, 1903, *pages* 75-76, *and* 3 *plates.*

The plant was required to discharge railway-wagons carrying 15 tons, at a single stroke, and to load the coal into canal-boats, the difference of level

between the quay and the surface of the water being only 10 feet (3 metres), and all the plant being driven electrically with current generated at a central station, 3 miles (5 kilometres) distant, by the waste gases of the coke-ovens.

The wagon is tipped sideways by a jack, or prop, guided by rollers, the upper end of which jack engages with the corner made by the bottom and one side of the wagon-body. The lower end of the jack has a pivot carrying a grooved pulley; and the movement is effected by a drive-chain, moored to a fixed point, passing round the above-named pulley and also the driving-pulley, a little below ground-level, terminating in a counter-weight for keeping the chain tight, while a cam on the jack, constantly bearing against a guide, keeps the wagon in contact during the operation of tipping. This operation is terminated by the automatic interruption of the current; and the empty wagon returns by its own weight and that of the jack, regulated by a powerful brake, capable of maintaining the loaded wagon, and normally kept applied.

The 15 tons of coal are received on a shoot, fixed at an angle of 37 degrees, with a shutter at its lower end for regulating the fall; and from this shoot the coal is delivered, by a travelling belt of the Lens type, into a fixed hopper, with an horizontal Archimedean screw at the bottom for removing the dust. Communicating with the hopper, and movable in a vertical plane round pivots in its sides, is a spout, terminating below in a beak, or curved end (also provided with a shutter) that turns on a vertical axis. The lower end of the spout is let down by a winch-and-chain into the boat; and the curved end is turned by mechanical means as required.

The boats are made fast to an endless rope, carried by two loose pulleys and driven by a grooved pulley round which it takes two turns, while a clutch permits of stopping the rope or drawing it in one or the other direction. A bridge over the canal affords the opportunity of watching the wagons and the boat, while there are brought together at this point, the levers that give motion to the travelling-belt, the loading-spout, the adjustable beak and the winch for moving the boats.

The pressure of the three-phase current is 5,000 volts, reduced to 240 volts by a transformer; and the two electromotors of 20 horsepower are started without a resistance-coil.

The plant, which can easily load 100 tons per hour, cost £3,200 (80,000 francs), and the cost of loading is less than ½d. (5 centimes) per ton.

J. W. P.

APPENDICES.

I. NOTES OF PAPERS ON THE WORKING OF MINES, METALLURGY, ETC., FROM THE TRANSACTIONS OF COLONIAL AND FOREIGN SOCIETIES AND COLONIAL AND FOREIGN PUBLICATIONS.

EARTH-TEMPERATURES AND GEOLOGICAL PHENOMENA.

Der Wärmeregime der Erdoberfläche und seine Beziehungen zu geologischen Erscheinungen. By L. Zaczewski. *Centralblatt für Mineralogie, Geologie und Palaeontologie*, 1904, *pages* 721-723.

The author proposes to issue shortly a memoir on this subject, in the German language. He points out that the "so-called internal heat of the earth" played a quite insignificant part, in comparison with the heat-energy derived from the sun. The available geothermic data are confined to medium latitudes and to a comparatively small number of points on the earth's surface, and they really afford no justification for the assumption that a source of high temperature exists in the core of the globe. The author has drawn up a series of diagrams, based on the facts recorded by the meteorologists, Mr. Angot and Dr. Ekholm, and these lead him to the following conclusions:—

1.—Low latitudes form a region of continuous accumulation of energy derived from the sun; while high latitudes form a region of continuous loss of energy.

2.—The hypothesis of the existence of a stratum of constant temperature at a shallow depth all over the earth is based on a misapprehension: such a stratum can only exist within well-defined limits in medium latitudes.

3.—The existence of eternally frozen strata in high latitudes is precisely attributable to (loss by) radiation of heat-energy.

The author discusses such questions as the beginning of geological life, the primary causes of mountain-building, etc., and finally summarizes his views in the statement that "the tectonic life of the earth's surface is the result of the action of the sun's heat-energy on that surface." Seas and continents, rivers and valleys, glaciers and volcanoes, earthquakes and secular changes of level, all alike arise from the same source as that whence the entire organic life of the earth and all phenomena of movement derive their power, that source being (in the author's opinion) the sun. L. L. B.

THE INFLUENCE OF TEMPERATURE ON THE MAGNETIC PROPERTIES OF MAGNETITE.

Über das Verschwinden und Wiedererscheinen des Magnetismus beim Erhitzen und Abkühlen von Magneteisenerz. By F. Rinne. *Centralblatt für Mineralogie, Geologie und Palaeontologie*, 1902, *pages* 294-305, *with* 3 *figures in the text.*

The author gives an account of the various experiments by which he has proved that if magnetite be raised to a red heat the ore loses its essential characteristic (essential at ordinary temperatures, at least) of

being attracted by the magnet. On cooling down again, it appears to regain possession of its magnetic properties. The temperature at which the loss of magnetism takes place is estimated at 1,067° Fahr. (575° Cent.). Previous to actual experimentation the author was unaware of this phenomenon, which, he says, is not mentioned in the mineralogical manuals. But he finds that Michael Faraday had recorded it in the *Annalen der Physik und Chemie* as long ago as 1836.

Apart, however, from mere qualitative experiment, the present author resolved to follow up the investigation by quantitative methods, that is, to measure the actual progress of the phenomenon at different temperatures. His results show that the magnetic susceptibility of magnetite at first increases gradually with heightening temperature, then, however, decreases suddenly and very markedly. With lowering temperature the phenomena follow a reverse order. The magnetite does not, however, regain on cooling its magnetic properties in as full a measure as it once possessed them: this diminution is explicable by the chemical change which the powdered ore undergoes in the course of experiment, despite the precautionary use of asbestos-stoppers for closing the glass-tube in which it is heated. The ingress of atmospheric air (which cannot be entirely prevented) alters in fact a portion of the magnetite from Fe_3O_4 into Fe_2O_3—a non-magnetizable oxide. The attempt to determine exactly the (magnetically) critical temperature did not meet with success. Certain theoretical considerations as to the distribution of magnetite in basalts are dealt with, and reference is made to the behaviour of metallic iron in regard to the magnet under varying conditions of temperature. L. L. B.

UNDERGROUND TEMPERATURES IN THE PARUSCHOWITZ NO. 5 BORING, GERMANY.

(1) *Über die Temperaturen in dem Bohrloche Paruschowitz V.* *By* Prof. F. Henrich. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate*, 1904, *vol. lii., Abhandlungen, pages* 1-11, *with* 1 *figure in the text and* 1 *Plate.*

(2) *Über die Temperaturverhältnisse in dem Bohrloch Paruschowitz V.* *By* Prof. F. Henrich. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 316-320, *with* 1 *figure in the text.*

The Paruschowitz boring, now the deepest in the world, has been carried down to the enormous depth of 6,571 feet, and the temperature-observations were, as in the case of the celebrated Schladebach boring, taken with "outflow-thermometers." These differ from the ordinary instruments in having their stems cut off at an angle of 60 degrees: several of them (six) are enclosed in a steel-cylinder which is sunk with the boring-rods down to the particular depth at which it is desired to record the temperature, and the thermometers are left there for 5 to 10 hours. They are then brought up to the surface, and in due order are placed in a recipient containing water; into this warm water is stirred until a mercury-drop of medium size appears above the opening. Simultaneously with the appearance of the mercury-drop the temperature of the water is read off an ordinary thermometer, and in this way the underground temperature is arrived at. The probable margin of error (either positive or negative) amounts to 0·2° Cent., but in practice errors three or four times as great have been made, and the author consequently recommends in future observations the use of maximum-thermometers.

At Paruschowitz, temperature-observations were taken at intervals of 102 feet (nearly) from the surface down to a depth of 6,425½ feet, at which point the unprecedented temperature of 69·3° Cent. or 156½° Fahr. was recorded. In order to avoid the errors of observation due to currents carrying warm water upward and cold water downward in the bore-hole, clayey mud or "slime" was pumped in, the frictional effect of which was sufficient to prevent the formation of such currents. At very great depths, where the rod occupies nearly the entire space of the bore-hole, the influence of these currents on temperature-observations is practically negligible. Other possible causes of error are enumerated; and, in order to avoid most of these, it is stated that temperature-observations should proceed *pari passu* with the progress of the boring, and should be carried out before pipes are inserted.

The boring was carried down through the Coal-measures, cutting on the way no less than eighty-two coal-seams ranging in thickness from 6 inches to 11½ feet, but one (at the depth of 3,698 feet) is about 33 feet thick. The total thickness of coal amounts to 290 feet, and the seams are interbedded with grey sandstones, sandy shales, quartz-grits, ironstone-shales, and conglomerates. The precautions taken to prevent inflows of water in the boring from vitiating the temperature-records are recited, and attention is then drawn both by word and by diagram to the important fact that the temperature was proved to increase constantly with the depth from the surface.

At first sight, the tabulated results appear to show that the ratio of increase is greater the farther one gets down from the surface, but the author hints that it would be rash to jump to this conclusion. The varying conductivity of the different strata accounts for much: thus, heat travels much more slowly through the compact 33 feet coal-seam than through the (comparatively) loose-textured sandstones overlying or underlying it.

The results are analysed and discussed by the author in great detail, and he sets forth his reasons for putting the increase of temperature as equivalent to 1° Cent. for every 31·82 metres or 104·37 feet of increase in depth from the surface. This ratio is greater than that calculated from the results obtained in the Schladebach and Sperenberg borings, but it would appear to be more reliable, the precautions taken at Paruschowitz and the experience previously gained having reduced the margin of probable error. It may be mentioned that the altitude of Paruschowitz is 833 feet above sea-level, and the mean annual temperature is 7·8° Cent. or 46° Fahr. L. L. B.

A FACTOR IN THE FORMATION OF SALT-DEPOSITS.

Über die Akkumulation der Sonnenwärme in verschiedenen Flüssigkeiten. By A. von Kalecsinszky. *Mathematischer und Naturwissenschaftlicher Anzeiger der ungarischen Akademie der Wissenschaften*, 1904, *vol. xxii.*, *pages* 29-53.

The author has been for some years engaged in the investigation of temperatures at various depths in the Hungarian salt-lakes (more especially in connection with the accumulation of solar heat therein), and he finds as the result of this investigation as well as of a series of elaborate experiments, that, if a thin stratum of fresh water overlies a saline solution, the deeper strata of that solution become warmer than the upper layers. This observation is confirmed by other temperature-records from salt-lakes in countries as far apart as Rumania, Norway, and Siberia.

Now, of the various salts which go to make up the Stassfurt deposits, for instance, some (such as polyhalite) are easily formed at a temperature of 77° Fahr., but others are formed only at very much higher temperatures. There, polyhalite is found interbedded with the upper layers of the deposits, while anhydrite occurs in the lower layers. The regular recurrence of this order of deposition is so marked that the miners compare it with the annual rings in tree-growth, and they connect it, as these are connected, with seasonal variation. Prof. Van't Hoff informed the author of his belief that anhydrite at Stassfurt represents a summer-deposit and common or rock-salt a winter-deposit. So, too, with the other salts, a critical point being reached in some cases where the temperature rises too high, in others where it falls too low, to admit of their remaining in solution. L. L. B.

FAULTS AND FOLDS.

Failles et Plis. *By* H. Douvillé. *Comptes-rendus hebdomadaires des Seances de l'Académie des Sciences*, 1904, *vol. cxxxviii., pages* 645-646.

The author defines faults as corresponding, in ultimate analysis, to a lengthening of a portion of the earth's crust which was in a state of tension; while folds correspond to a shortening of some part of the earth's crust, and are primarily due to compression. He then considers the distribution on the surface of the globe of fault-areas where the effects of tension are predominant, and fold-areas where those of compression dominate. The former category seems in some way to follow the parallels of longitude: take, for instance, the shores of the Pacific, marked out by the chain of the Andes on one side, and by the volcanic islands of Japan and the Javan-Sumatran group on the other. The belts marked by the Ægean, the Red Sea, and the Mozambique Channel are equidistant. The Atlantic, too, may represent an area of sagging due to faults. The fold-areas are transverse to those just considered, and generally follow the parallels of latitude: they are characterized by the Caledonian, Hercynian and Alpine chains.

To sum up: during geological time, the length of the Equator has not varied to any considerable extent, while the meridians have certainly diminished in length. Whence it may be inferred that the flattening of the terrestrial spheroid has become gradually more marked, and the rotational movement of the earth has been correspondingly accelerated. L. L. B.

THE CONCENTRATION-THEORY AND THE GENESIS OF ORE-DEPOSITS.

Die Bedeutung der Konzentrationsprozesse für die Lagerstättenlehre und die Lithogenesis. *By* Dr. Rudolf Delkeskamp. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 289-316.

The author begins with the remark that the concretionary processes going on within sedimentary material deserve far greater attention than has hitherto been paid to them, in connection with the study of ore-deposits and the formation of rocks in general. By the term "concentration" he implies the accumulation of any homogenous substance, for he assumes that in the primitive or original magma all substances were present, evenly distributed and intermingled.

This memoir is intended to supplement the work of Messrs. Vogt, Clarke and Hillebrand, Klockmann, and others, and deals at greatest length with those processes of concentration which originated ore-deposits other than veins, as well as various mineral formations of industrial importance although they do not fall within the definition of "ore-bodies."

The author classifies concentrations as (1) pre-existing, (2) primary, and (3) secondary: to the first category belong clay-galls in sandstone, the dolomite and limestone-nodules in the Rothliegende and the Bunter Sandstone, and placer-deposits, etc., formed by selective sedimentation.

The second category includes several subdivisions, such as (*a*) deposits formed by submarine mineral springs (under these Dr. Gümbel included the manganese-nodules dredged up in the *Challenger* expedition, but the author does not accept that explanation and ranges them under *c*); (*b*) concentration induced by local variation in the supply of detritus (such as the sphærosiderite-nodules in clay-slates, the Huelva pyrites, according to Dr. Klockmann, the Jurassic pisolitic iron-ores of Lorraine, etc.); (*c*) accretion and decomposition going on during the formation of a sediment; (*d*) mutual precipitation of locally-introduced metallic salts and of particles in suspension by adsorption; (*e*) formation of chemical sediments by the gradual dessication of gulfs shut off from the sea (lagoons), or in consequence of the increasing concentration of waters occupying depressions which had no outflow; and (*f*) successive precipitation from mineral-springs.

To the third category belong deposits originating (*a*) from the concentration of a substance which either was from the first distributed evenly throughout the sediment, or arose from the subsequent oxidation or reduction of such a substance; (*b*) from the concentration of a substance formed by the interaction of two or more bodies, which were primarily distributed evenly throughout the sediment; (*c*) from the concentration of substances, which were in part originally present in the sediment, or in the weathered residuum or decomposition-products of crystalline and sedimentary rocks, but were also in part introduced secondarily by thermal waters, etc.; (*d*) from the concentration of substances which were brought in by infiltration, and replaced metasomatically the primary material; (*e*) from concentrations initiated by secondary infiltration, but confined by adsorption to certain layers of a complex of bedded rocks; and (*f*) from concentrations similarly initiated, but in the form of aqueous solution, the infiltration arising from thermal springs or from the leach-waters of overlying beds.

Examples of deposits in all parts of the world are cited and described under these various headings; but it must suffice here to recite the author's main conclusions, in regard to epigenetic deposits which are precipitates from aqueous solution. They are as follows:—

(1) Ore-deposits may originate from solutions of the most diverse chemical composition, at various temperatures and pressures. Nevertheless, these solutions will have been preferably alkaline, and temperature and pressure will have been mostly high.

(2) The metal-bearing solutions may travel in any possible direction, yet in the main they will have travelled from below upward.

(3) Precipitation will have been induced by such variations in the conditions as decrease in pressure and temperature, increase of concentration by the evaporation of the water or by the escape of carbon dioxide and other gases; or perhaps by the mixture of various solutions travelling from different points. Moreover, the chemical nature of the country-rock must influence the character of the infilling of a vein.

(4) The solutions will have derived their metalliferous particles chiefly from "magmatic centres" (in the sense used by Dr. Stübel) or from the central region of the globe; those few, the components of which have been derived from the leaching-out of rocks, can in the majority of cases be traced to the lowermost rocks of the earth's crust (the so-called "thermosphere"). It is not denied, however, that the rocks of the upper regions of the crust and the country-rock of metalliferous veins have contributed their quota to the infilling of metalliferous fissures. L. L. B.

THE ORIGIN OF PHOSPHORUS IN IRON-ORES.

Sur l'Association géologique du Fer et du Phosphore et la Déphosphoration des Minerais de Fer en Métallurgie naturelle. *By* L. DE LAUNAY. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii., pages* 225-227.

The author has attempted to investigate the laws which determine either the association of iron and phosphorus in nature or their separation, with the view of making it possible to predict in what class of deposits we may *a priori* expect to find iron-ores free from phosphorus. His general conclusions are (1) that the association of the two elements is primarily of deep-seated origin, and he quotes in this connection the presence of phosphide of iron in meteorites: traces of phosphorus, too, are present in certain metalliferous veins; (2) that in the process of natural "scorification" which gave rise to the various silicates of alumina of which the earth's crust is chiefly made up, such phosphorus as existed in the state of a deep-seated phosphide was everywhere rapidly oxidized, and then absorbed by lime in the form of apatite; and (3) that the dephosphorization of sedimentary iron-ores by metamorphism is the more likely to occur in proportion as the iron-ores in question are of more ancient date.

In principle, very little phosphorus is found in ores of basic segregation (magnetites and titano-magnetites); very little also in those which, commencing by the metasomatic replacement of limestone, have passed through the stage of carbonates, before undergoing peroxidation and hydration nearer the surface. On the other hand, the author explains how sedimentary iron-ores must be expected to contain more or less phosphorus, unless subsequently purified by secondary reactions producing natural dephosphorization, as above-mentioned. In some districts, such as Norberg in Sweden, and the Vissókaya Gora in the Urals, siliceous ores highly charged with phosphorus are found alongside calcareous ores comparatively free from it. Generally speaking, it is found that those same phenomena which have had the effect of cleansing an ore of much of its phosphorus, have increased its original percentage of manganese; and less frequently, its percentage of barium or cobalt. L. L. B.

THE PART PLAYED BY PHOSPHORUS IN ORE-DEPOSITS GENERALLY.

Sur le Rôle du Phosphore dans les Gîtes Minéraux. *By* L. DE LAUNAY. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii., pages* 308-310.

In the processes of natural metallurgy which have resulted in the formation of igneous rocks and metalliferous ores, certain metalloids by combining

with the metals seem to have enhanced the mobility of the latter and to have facilitated their ascent towards the surface. These metalloids, termed "mineralizers," are more especially chlorine and fluorine, sulphur and its homologues (selenium and tellurium), and finally arsenic and antimony. Attention has not been so largely directed to the part played by other metalloids, whose affinity for oxygen impels them to enter at once into combination with that element (as soon as approach to the surface affords an opportunity), and marks to a certain extent their relation to the metals. Chief among these is phosphorus, generally found in combination with lime in nature, because of the almost ubiquitous presence of that alkaline earth in the silicate-crust of the globe.

It appears probable that phosphorus, either in the elemental state, or in combination as phosphoric acid, has not infrequently acted as a "mineralizer" in the metallurgical processes of nature, simultaneously with chlorine and fluorine. This would seem to apply especially to the white-mica granites and to the stanniferous and uraniferous veins characteristic of them.

Vanadium, in the author's opinion, plays a part absolutely analogous to that of phosphorus, though more rarely. L. L. B.

THE FORMATION OF VANADIUM-ORES.

Sur la Formation dans la Nature des Minerais de Vanadium. *By* A. Ditte. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii., pages* 1303-1308.

The only vanadium-ore that occurs in nature in any abundance is the vanadate of lead, occasionally combined into a chloro-vanadate. Vanadium itself is widely diffused in the earth's crust, occurring in minute, or rather infinitesimal proportions, in iron and other ores, and also in clays, grits, etc. Exactly in what form it so occurs is difficult to predicate; but it is at all events accessible to the dissolving action of pluvial or infiltrated waters, and so is converted into vanadic acid, and this again forms soluble vanadates. Waters charged with these and other salts possess the faculty of leaching out copper, zinc, lead, and other metals from the older rocks in which they are disseminated. If such waters come into contact with weak solutions of lead sulphate derived from the oxidation of galena, they form vanadates of lead, such as those found in the Wanlockhead and Beresov mines. In the presence of chlorinated solutions vanadinite or chloro-vanadate of lead may be formed, as Sir H. E. Roscoe and Prof. Hautefeuille have successfully proved by synthetic experiments. These ores do not even require for their genesis complete solution of the sulphate of lead, as the author's own experiments have shown. In the Santa Marta mine, in Spain, vanadate of lead occurs in association with cerussite on the top of galena. Of course, the action of pressure, in activating the solubility of certain intractable ores in the percolating waters, has to be taken into account. The author considers that his explanation of the origin of the ores of vanadium fits in exactly with their occurrence, as observed in various localities in Europe and America.

L. L. B.

THE FIGURE OF THE EARTH IN RELATION TO EARTHQUAKES, ETC.

Relation des Volcans et des Tremblements de Terre avec la Figure du Globe. By Ch. Lallemand. *Compte-rendu de la Trente-deuxième Session* (1903) *de l'Association française pour l'Avancement des Sciences, part ii.*, 1904, *pages* 157-168, *with* 3 *figures in the text.*

Under the term "earthquakes" the author includes not only the tremors perceptible to our ordinary senses (of which on an average about two occur daily in some part of the inhabited world, and possibly about fifty *per diem* if we take the surface of the entire globe), but also those continuous internal vibrations which instruments of extreme sensitiveness are alone capable of recording. These slight earth-movements, which seem to be amplified by barometric depression, are more frequent in winter than in summer, and usually increase in intensity at the approach of the equinoctial periods.

After pointing out that vulcanicity and seismicity have, during the last year or two, become vastly more active, after a period of comparative quiescence, the author discusses the tetrahedric theory of the figure of the earth in a favourable sense, and dismisses successively the principal objections which have been raised to it. He then urges that, although volcanic eruptions and earthquakes constitute two distinct orders of phenomena, they are both alike the natural and logical consequences of the movements of the lithosphere resulting primarily from its contraction on cooling. These phenomena are more likely to occur at those points where the crust has undergone greatest deformation, points which, in fact, form the zones of least resistance. We may expect to find these in the regions neighbouring the "crests" and apices of the tetrahedron, and especially in the great inter-continental depression where the torsion of the austral apex of the terrestrial "spinning-top" superimposes its influence on that of the plication of the tetrahedral ridges. Moreover, the possible existence of an internal "luni-solar tide," concordant with the great oceanic tides, might, in the vicinity of the Equator and in the entire tropical belt, cause on some occasions a rupture of equilibrium. These statements are confirmed by the examination of a map of the world, showing the distribution of seismic and volcanic phenomena, and their connection with the great inter-continental depressions.

L. L. B.

GEOSYNCLINALS AND SEISMICITY.

Sur la Coïncidence entre les Géosynclinaux et les Grands Cercles de Sismicité maxima. By F. de Montessus de Ballore. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxix., pages* 686-687.

The author has already shown that the regions especially subject to earthquakes are comprized within two narrow belts coincident with two great circles of the globe. Now, these are found to coincide precisely with the geosynclinals of the Mesozoic era, which later, in the Kainozoic or Tertiary era, gave place to the great lines of corrugation of the earth's surface. It follows from this that 94 per cent. of the recorded earthquakes correspond to general movements of the crust, whereby the sediments of the ancient geosynclinals, folded and thrust up, have ultimately come to form the geanticlinals or great mountain-ranges, the upheaval of which is of comparatively recent date.

Seismic instability could hardly be uniform along these belts, because the movements do not synchronize and they differ in amplitude. In some cases, the seismicity of a given region is found to be proportionate to the mass of the upheaved sediments.

If we consider the older geosynclinals, as, for example, those in which the Coal-measure basins were laid down before the post-Carboniferous foldings, seismic areas may be plotted out, of moderate instability merely (because of the antiquity of the movements of the crust there), but strictly limited to those basins. This observation may be extended to all the Coal-measure regions of the globe, excepting those that lie within ancient folded massifs. The author concludes that there is a remarkable homology between ancient and recent geosynclinals, and that the general cause of earthquakes is intimately connected with the great movements of the crust, without thereby excluding secondary, that is, local and more immediate causes. L. L. B.

SEISMOLOGICAL PHENOMENA IN CENTRAL EUROPE.

Seismologische Untersuchungen. *By* S. Günther *and* J. Reindl. *Sitzungsberichte der mathematisch-physikalischen Klasse der königlich-bayerischen Akademie der Wissenschaften zu München,* 1903, *pages* 631-671, *and* 1 *plate.*

The first part of this paper is devoted to a careful collation and scientific investigation of the accounts which have been handed down to us of two of the most terrible earthquakes that have ever been recorded in Central Europe. The first of these took place on January 25th, 1348, and with Carinthia for its pleistoseismic area (including the towns of Villach and Klagenfurt) made its effects felt over a region extending from beyond Vienna in the east to Basel in the west, and from Frankfort-on-the-Main in the north to Naples in the south. The second took place in 1356, on St. Luke's day, and affected Bavaria among other countries.

The next part of the paper deals with the seismicity of the Ries basin, which in respect of earth-tremors is quite an exceptional district—so far as Bavarian territory on the right bank of the Rhine is concerned. A description is given of the principal earthquakes recorded in this district between the years 1471 and 1903; and it is pointed out that as none of these appear to have made themselves conspicuously felt far beyond the district, the epicentrum must lie within it. The latest recorded earth-tremors there took place between 5 and 6 a.m. on August 11th, 1903. Now, the Ries is a volcanic district, and the seismic phenomena noted there are classified by the authors as volcanic-tectonic or imperfectly tectonic, and are perhaps the long-continued results of an internal break-up of the earth's crust, due to vulcanicity in former ages.

The third part of the paper treats of the peculiar sounds variously known as "Barisal guns," "mist-pouffers," etc., but which the authors prefer to denominate "earth-reports" or "earth-bangs" (*Bodenknalle*). They do not concur in the view that any of these sounds are of atmospheric origin, it heard over wide areas: they admit indeed that such detonations may in some rare cases be traced back to atmospheric causes, but do not then possess sufficient inherent energy to travel far. On the whole, they regard most of these detonations are due to feeble, "embryonic" earth-shocks, not otherwise perceptible by the human organism. L. L. B.

EARTHQUAKES AND EARTH-TREMORS IN PORTUGAL IN 1903.

1. *Les Tremblements de Terre de 1903 en Portugal.* By Paul Choffat. *Communicações da Commissão do Serviço geologico de Portugal*, 1904, *vol. v., pages* 279-306, *and* 1 *plate.*

2. *Sur les Séismes ressentis en Portugal en 1903.* By Paul Choffat. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii., pages* 313-315.

Feeble shocks of earthquake are of frequent occurrence in Portugal, but the little kingdom does not yet boast a properly-organized seismological service, and the question of establishing recording-apparatus in the various meteorological observatories is still "under consideration."

On August 9th, 1903, a shock of unusual violence took place, which attracted universal attention, only three fairly comparable with it having occurred in Portugal within living memory. Feebler shocks followed in September and October. To return to the principal shock of August 9th: it was felt over nearly the whole area of Portugal, and across the Spanish frontier in the provinces of Huelva, Seville and Badajoz. It occurred about 10.15 p.m., and was accompanied by a barometric rise of 2 millimetres (observed at Lisbon). The temperature of the air at the time was rather over 64° Fahr. There was a preliminary vibration (horizontal) lasting 3 seconds, then an interval of 2 seconds, followed by a second vibration, stronger than the first, lasting 10 seconds, with a motion changing from vertical to horizontal. The usual earthquake-sound was heard, compared by some observers to a detonation, but by most others to the rumbling and rattling of a wagon laden with iron-bars. The shock appears to have travelled from east to west: the intensity was from 7 to 8 (in the De Rossi-Forel scale) over an area extending along the coast for 112 miles from north to south, that is from Lourinhã to the mouth of the Mira, but only for 20 miles or so from west to east. Within this area falls of chimneys, roofing-slates, etc. and the fissuring of walls, were recorded from many localities; and in Lisbon the effects (intensity 7) were such as to cause widespread terror among the audiences in the theatres, the patients in the hospitals, etc. The inhabitants of entire streets were panic-stricken, and some people rushed out of doors without stopping to dress themselves. The intensity was really greatest in the Arrabida range; as the same observation has been made in previous earthquakes, the cause may lie in the asymmetrical, all but monoclinal structure of that range, the southern flank of which plunges abruptly into a sea of considerable depth.

An after-shock made itself perceptible, over a much less extensive area, on September 14th, 1903, at 1·30 p.m. It is true that its intensity (7) was nearly as great as that of the principal shock (of August 9th), but as its duration was much shorter the effects were proportionately smaller. The direction of travel was again from east to west, and no vertical motion was observed. Earthquake-sounds were reported from Cezimbra and Cintra; material damage was noted only at the latter place and at Lisbon. Plotting out the isoseismals, the author obtains, as in the case of the earthquake of August 9th, two concentric zones open towards the Atlantic, the difference being that on September 14th the epicentral area coincided with the Serra de Cintra instead of coinciding with the Arrabida range.

Further after-shocks were recorded on September 28th (8 a.m.) and December 1st (6·40 a.m.), the second chiefly at Huelva; and on October 14th at 2·55 p.m. That of October 14th was noticed at localities lying north and

south of the Serra do Monte Junto, and is believed to have been due to sagging along the fault-lines characteristic of the above-mentioned range.

A short description is given of previous earthquakes in Portugal, from 1755 onwards, and the author then lays down certain general conclusions. He distinguishes three categories of earthquakes in Portugal, the first of which includes those of considerable extent, one principal centre lying in the depths of the Atlantic opposite the western coast (generally in the latitude of the Arrabida range or else of the Cintra range). The zones of equal intensity cover areas consisting of rocks of the most diverse nature, and the records are neither sufficiently accurate nor sufficiently numerous to predictate the relationship between the seismic phenomena and the lithology of the country which they affect. Irregularities in the isoseismal curves may be traced to the effect of mountain-massifs; and there is, further, no doubt that a more intimate knowledge of the distribution of the seismic intensities will reveal a causal connection with great fault-lines, as well as with great ocean-depths.

On the whole, the earthquakes by which Portugal is shaken at intervals have two principal centres: that previously mentioned as lying out at sea, on the latitude of the mouths of the Tagus and the Sado, and another in Andalusia. Sometimes, an earthquake proceeds from one centre, sometimes from the other; and occasionally it proceeds alternately from both.

L. L. B.

THE EARTHQUAKE OF SHEMAKHA, SOUTHERN RUSSIA, 1902.

Shemakhinskoye Zemlitryasenie. *By* V. Weber. *Trudi geologicheskago Komiteta*, 1903, *series* 2, *No.* 9, 73 *pages, with* 56 *figures in the text and* 3 *plates.*

This most destructive earthquake took place on February 13th, 1902 (January 31st in the Russian calendar). The author's researches were confined to the area externally delimited by the isoseismal corresponding to 8 in the De Rossi-Forel scale; thorough investigation was rendered difficult by the low stage of civilization of the natives of the Caucasus, and by the complete absence of seismological stations provided with registering instruments such as would have furnished authentic records.

The isoseismal areas of the Shemakha earthquake, corresponding to 8, 9 and 10 in the De Rossi-Forel scale, are divisible into seven categories, as follows:—

X.—(1) Hardly a building left intact: walls demolished almost completely.

IX.—(2) Some buildings standing though badly damaged. Many entirely demolished. (3) Solidly-built structures standing: less solid structures a heap of ruins. Many walls thrown down. (4) Solidly-built structures damaged in part: some of the less solid ones left standing.

VIII.—(5) Less solidly-built structures: about 50 per cent. left standing. (6) Partial damage to buildings in places. (7) Not much damage to buildings.

The district which suffered the most from the shocks lies on the southern slope of the main range, which gradually passes by a series of terraces down into the Kura plain. These terraces trend parallel with the strike of the rocks, and parallel with the main range, from west-north-west to east-south-east: they are cut through by three principal river-valleys and by a whole network of small streams and gullies. The isoseismal area over which buildings were destroyed was about 50 miles in length by 23 miles in width.

On the whole, the great river-valleys seem to have acted as barriers to the extension of the shocks, a part played in a lesser degree by some of the smaller valleys. The influence of rock-foundations in minimizing damage to buildings, as compared with those built on less compact strata, is also noticeable. On the other hand, villages built on thick deposits of alluvium suffered less than those built on comparatively thin alluvia overlying solid rock (an especially dangerous combination). Isolated hills and escarpments are also shown to be dangerous localities from the seismic point of view. The initial shock was preceded by a subterranean rumbling: the shock appeared to travel from west to north-west and back again, and was succeeded by undulations of "mixed character," during which people had difficulty in keeping their feet. General panic prevailed, and the confusion is described as terrible. Some springs ceased to flow and others flowed in increased volume. In some places fissures were opened up in the earth, and there were eruptions of small "mud volcanoes." This earthquake of 1902 appears to be identical in many respects with that recorded in the same area in 1859. L. L. B.

EARTHQUAKES IN RUMANIA AND BESSARABIA.

Sur les Tremblements de Terre de la Roumanie et de la Bessarabie. *By* F. de Montessus de Ballore. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii., pages* 830-832.

The systematic observations made by the Rumanian Meteorological Department during the past 12 years make it now possible to draw up a seismological chart of that kingdom and of Bessarabia. An inspection of this shows that the seismic epicentres are most thickly clustered along a line drawn from Kishinev to Bucharest.

Western Wallachia, the entire Danubian terrace between Turn-Severin and Kalarash, the Dobrudsha, and Northern Moldavia constitute a region of far greater stability than Bessarabia, or more especially than Central and Southern Moldavia, and Eastern Wallachia. It is curious to note that the Kishinev-Bucharest axis, ranging north-east and south-west, is parallel to the seismic axis of the Bohemian Erzgebirge, to the petroleum-belt of Ramnicu-Sarat, and to the strike of the volcanic rocks and principal metalliferous veins of the western districts of Wallachia.

In former ages, the shore-line between Odessa and the mouths of the Danube was visited by violent earthquakes, the epicentres of which appear to have lain out somewhere in the middle of the Black Sea: perhaps, they represented a moribund stage of the Caucasian-Balkanian dislocation, which caused the comparatively-recent depression of the eastern portion of that sea.

L. L. B.

EARTH-TREMORS IN SWEDEN IN 1902 AND 1903.

Meddelanden om Jordstötar i Sverige No. 13. *By* E. Svedmark. *Geologiska Föreningens i Stockholm Förhandlingar*, 1904, *vol. xxvi., pages* 201-209.

According to the newspapers, on April 29th, 1902, shortly after 2 p.m., violent earth-tremors were felt at several localities in Halland and the bordering districts. At certain points along the Halmstad and Nässjö railway there was a thunderous subterranean rumbling, houses quaked, and articles of furniture were set in motion: accounts agree in fixing the duration

of the phenomenon at about 60 seconds. Curiously enough, the Central Meteorological Institute at Stockholm had, at the date of writing, received no reports in regard to these earth-tremors in Halland, but had, on the other hand, received much information as to earth-tremors having been observed on the same day and the following day in Western Gothland and Småland. These shocks were fairly severe, as they caused much rattling of windows and clattering of crockery, but they were not sufficiently so to cause damage to property or injury to persons. The times given range between 2 and 2·30 p.m., and the directions vary (on the whole) from east and west to north-east and south-west.

On some date between the 12th and 18th of October of the same year, two earth-tremors were observed at Ystad, accompanied by a short and sharp subterranean rumbling.

January of 1903 had been but two days under way when a similar phenomenon was reported from Umeå. Then on April 11th, at 8·30 p.m., in the Upland district, a shock of earthquake caused the houses in various localities to vibrate to such an extent that the terrified inhabitants ran into the street. Some averred to have seen the flash of a meteor.

On August 26th, at 6·55 p.m., a slight earthquake took place in the eastern portion of the districts of Filipstad and Örebro, and was attended with the customary subterranean rumblings. Houses shook, in certain cases, but no damage appears to have been done.

Earth-tremors were also recorded, of some severity, in Eastern Gothland (September 19th, 6·15 p.m. or thereabouts) and in Western Bothnia (October 4th, 5·25 p.m.). The author makes no suggestion as to the origin of all these earth-tremors—that is, whether they were due to sagging along fault-lines, or to some other cause. L. L. B.

THE SEISMICITY OF NORTHERN AFRICA.

Sur les Conditions générales de la Sismicité des Pays Barbaresques. *By* F. de Montessus de Ballore. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii., pages* 1443-1445.

The districts comprized within ancient Barbary form a typically-unstable region as regards earth-tremors. The isobathic contour of 13,000 feet runs parallel to the north-western coast of Africa, not very far out to sea, and is probably the fault-line along which the basin of the Western Mediterranean has sunk, while on the other side of it, at a comparatively recent period also, has arisen the ridge of the Tellian Atlas. Parallel to these, too, run on the one hand a belt of eruptive rocks and on the other the dismantled remnants of an ancient Archæan and Palæozoic chain. Observation has shown that such tectonic conditions almost inevitably bring about seismic instability.

The frequent earthquakes of the Algerian coast-line may be traced, then, to the uprise of the Tellian Atlas. But several seismic areas, each independent of the other, may be plotted out on the map of Algeria. For instance, that of Oran does not overlap the volcanic district of the Lower Tafna, and the Shelif Valley constitutes an almost insurmountable obstacle to the propagation of earthquakes, either from the east or from the west of the colony. The most unstable portion of the Tellian Atlas is the southern rim of the Mitidja.

The ancient massif of Kabylia reveals the ordinary characteristics of highly-dislocated areas, that is, numerous epicentres, and earth-tremors more remarkable for their frequency than for their violence. East of the Shelif,

the southern flank of the Tellian Atlas is just as unstable as the northern. On the other hand, the Alta region between the two Atlas ranges is particularly stable, except on the east where the Hodna depression forms a seismic centre of some importance. The Saharan Atlas is very stable on the west up to Bu-Sanda, which marks the beginning of the remarkable seismic area of Aurès and Nemensha.

The Tripolitan area, in common with Cyrenaica and the Sahara, is extremely stable. In Tunisia, a seismic belt may be traced from Gabès to Tozeur, and there is probably some relationship between the seismic centre of Tunis itself and the Zaghuan faults.

Concerning Morocco next to nothing is known, but the region around Fez and Mequinez is much shaken by earth-tremors, along a belt corresponding to the former inflow of the Miocene Sea into the Oran district, and symmetrically situated in regard to the Guadalquivir Gulf (itself an area of high seismicity). Neither shore of the Straits of Gibraltar is remarkable for its seismic stability. The author observes, in conclusion, that most of the towns of Algeria have been built in such situations as to suffer the greatest possible damage from earthquakes. L. L. B.

EARTHQUAKES IN MEXICO, 1902.

(1) *Informe sobre los Temblores de Zanatepec a fines de Setiembre de 1902, y sobre el Estado actual del Volcán de Tacaná.* *By* Emilio Böse. *Parergones del Instituto geológico de Mexico*, 1903, *vol. i., pages* 5-25 *and* 4 *plates.*

Zanatepec is situated in the State of Oaxaca, at the southern base of the range which forms the backbone of the Isthmus of Tehuantepec. Between September 24th and 30th, 1902, twenty shocks of earthquake were felt, accompanied by subterranean rumblings, which were reverberated from the circular lakes known as "the Sun and the Moon" (Sol y Luna). On the 23rd of the same month, the whole south-eastern region of Mexico had been shaken by an earth-tremor, the epicentrum of which lay somewhere in the State of Chiapas, and the shocks felt at Zanatepec are undoubtedly to be connected with this preliminary shock. The violence of the last-named is given as 6 in the De Rossi-Forel scale, and the pleistoseismic area was a belt some 62 miles long and more than 15½ miles broad. Buildings suffered considerable damage, in some cases, far beyond this belt. A study of the tectonic structure of the region leads to the conclusion that the epicentral line of seismicity coincides with a succession of step-faults, and hence that the earth-tremors were due to a sagging movement along one or more of those faults.

The author visited the "Sun and Moon" lakes, and holds that they are not of volcanic origin (they were supposed to be crater-lakes, but their maximum depth does not exceed 82 feet). He describes the present condition of the volcano of Tacaná, on the frontier between Guatemala and Mexico, and concludes that, although not actually extinct, it resembles in many respects a moribund volcano. The last definitely-recorded eruption from the summit took place in 1855.

(2) *Informe sobre el Temblor del 16 de Enero de 1902 en el Estado de Guerrero.* *By* E. Böse *and* E. Angermann. *Parergones del Instituto geológico de Mexico*, 1904, *vol. i., pages* 125-131.

On January 16th, 1902, at 4·15 p.m., an earthquake took place in the above-mentioned State, of which rather panic-stricken accounts were pub-

lished in the newspapers. Taking into consideration the general flimsiness of the buildings in the towns where most damage was done, the authors infer that the intensity of the shock really lay somewhere between 5 and 6 in the De Rossi-Forel scale. In Chilapa, Chilpancingo and Tixtla, the direction of motion seems to have been approximately from north to south. In the more remote villages, the available evidence points to various directions of motion: this, coupled with the fact that the shock was most severely felt in the three towns above-mentioned, inclines the authors to the belief that the epicentrum lay somewhere in the neighbourhood of these towns, perhaps near Chilpancingo, and that the cause of the earthquake was the slipping of a "fault-block" over an east-and-west fracture (the general strike of the rock-fractures in that region ranging indeed east and west).

Investigation proved that the reports of yawning fissures having been opened up in the earth in two localities, and of a new volcano having sprung up near Atoyac, as a consequence of the earthquake, were, to all intents and purposes, unfounded.

In conclusion, it is pointed out that orogenic movements are still going on in that part of Mexico, and consequently that earthquakes may be looked for, from time to time, as a necessary accompaniment of the process of mountain-building. L. L. B.

VEGETABLE SOILS OF THE COAL-MEASURES.

Sur les Sols de Végétation fossiles des Sigillaires et des Lépidodendrons. By C. Grand'Eury. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii., pages* 460-463.

The shaly clays, which often form the roof and partings of coal-seams, when full of Stigmarian roots represent old vegetable soils, the more interesting that they are often overlain by prostrate Sigillarias and Lepidodendrons, which appear to have fallen in the place where they grew (as at Communay in Dauphiné, and at Hattingen in Westphalia). The author agrees with Prof. Potonié that *Stigmaria* represents an autochthonous vegetation, but adds that it was an aquatic plant and extended indefinitely by creeping along a submerged floor, where no other vegetation could take root. At Matallana, in the province of Leon (Spain), there is a shale-outcrop with *Stigmaria minor* radiating in quadripartite fashion from swollen rhizomes, from which stems would have doubtless sprung up if the water had not been too deep. Indeed, it would seem that *Stigmaria* did not prosper well in deep water, for at Rive de Gier, in the Loire coal-field, it finally disappears westward, in the direction towards which the old basin deepened. On the other hand, it flourished in the shallow waters of the northern rim, in company with Calamitean plants, and there began to put forth stems and grow trunks. In the old Coal-measure forests of St. Etienne and Alais, *Sigillaria* is succeeded downward by *Syringodendron*, and the trunks of the latter are based on *Stigmariopsis*. In point of fact, the author believes that many of the Stigmarian rhizomes helped to propagate *Sigillaria* in the Coal-measure marshes, and this probably holds good of *Lepidodendron* also. He was not always of this opinion, but he has recently accumulated evidence which has induced him to revise his former conclusions. In their ordinary state of preservation the Stigmarian rootlets traceable to *Sigillaria* cannot be distinguished from those traceable to *Lepidodendron*. It is true that different varieties of *Stigmaria ficoides* are known, and the author can differentiate

the Westphalian form from that which occurs in the uppermost measures of St. Etienne. The extraordinary fixity in the character of the rhizomes of the Lepidophyta of the Coal-measures, when contrasted with the variability of the trunks and stems from species to species, seems to point to a common origin for them all. L. L. B.

MARSH-VEGETATION AND THE ORIGIN OF COAL.

Sur le Caractère paludéen des Plantes qui ont formé les Combustibles fossiles de tout Age. By C. Grand'Eury. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii., pages* 666-669.

The author begins with pointing out that recent research in the St. Etienne coal-field has shown that all the fossil plants from which its seams are derived were marsh-dwellers, or of distinctly aquatic habit. The later and rarer plants found in the upper beds, there and in the Autun coal-field such as *Pterophyllum, Nœggerathia, Zamites,* etc., are the ill-preserved fortuitous relics of a comparatively-monotonous dry-land flora, which played practically no part in the constitution of ancient fossil fuels.

During the last 4 or 5 years, the author has studied the brown coals and lignites of Keuper, Oolitic, Cretaceous and Tertiary age, and has come to the conclusion that just as Coal-measure coal, these newer deposits are derived from marsh-vegetation and aquatic plants. The lignites, it is true, can be generally traced to Coniferæ, but these conifers all belong to species which live best near water, or actually with their "feet in the water." It is true again that in very recent lignites, remains of palm, alder, laurel, etc., have been found, and so exceptions must be admitted in the case of this class of fossil fuel. The exceptions, however, do not appear to invalidate the general rule, laid down by the author, that marsh-vegetation was the main source of all varieties of coal. L. L. B.

CONTACT-METAMORPHIC MAGNETITE-DEPOSITS.

Über kontaktmetamorphe Magnetitlagerstätten, ihre Bildung und systematische Stellung. By F. Klockmann. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 73-85.

The author considers that all magnetite-deposits of any consequence belong to one of the following categories:—(1) They are locally-concentrated constituents of eruptive rocks; or (2) they are a normal phase of the series of crystalline schists; or finally (3) they are so-called "contact-metamorphic" deposits, associated, as to position, with eruptive rocks. In regard to the origin of the first category all observers are now in practical agreement. With regard to the second, there is little doubt that they represent deposits originally of hæmatite or spathose iron-ore, which underwent the same processes of regional metamorphism as those to which the rocks that are now the crystalline schists were subjected. The question of the genesis of the third category, however, has not been settled beyond dispute. There is a widespread notion that such magnetite-deposits owe, not alone their chemical composition, but their very existence, to contact-metamorphism, and primarily, therefore, to the eruptive rocks which brought about that metamorphism. This view the author attacks as absolutely mistaken, and as being in contradiction with much of the available evidence. He goes step by step

through the arguments upon which this view is usually based, and claims that they fail to fit in with the facts, as observed in the iron-ore deposits of Nassau, the Harz, the Sierra Morena, and Algeria, among other regions.

The author's opinion is that contact-metamorphic magnetite-deposits were originally either hæmatites, spathose iron-ores, or in some cases pyrites, or even the regionally-metamorphic magnetites of the Archæan Series. In the vast majority of instances there is no ground for assuming the intervention of any other agencies in the process of peroxidation than the high temperature and consequent heating effect of the eruptive rock, coupled with the presence of steam and the exertion of a certain amount of pressure. The typical "contact-metamorphic" deposits of magnetite are to be ranged alongside the magnetites of the crystalline-schist series, from which they differ merely in age and in the nature of the metamorphism which altered iron-ore deposits primarily of sedimentary (or, in some few cases, of metasomatic) origin.

Finally, the author enters a protest against the prevalent system of classifying ore-deposits according to their genesis, real or presumptive. He holds that, in the present state of knowledge, a comparative classification, laying chief stress upon geological and mineralogical similarities and relationships, is by far preferable. L. L. B.

THE INFLUENCE OF METAMORPHISM UPON THE MINERALOGICAL COMPOSITION OF PYRITES-DEPOSITS.

Über den Einfluss der Metamorphose auf die mineralische Zusammensetzung der Kieslagerstätten. By F. Klockmann. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 153-160.

The author considers that the part played by metamorphism in regard to mineral-deposits has been often misconceived, if not neglected, by investigators. He disagrees with the generally-accepted hypothesis of the epigenetic origin of typical pyrites-deposits, and favours the view that, so far from presenting any analogy with subsequently-formed metalliferous veins, they are (broadly speaking) contemporaneous with the surrounding "country-rock." They are divisible into two categories:—(1) Those which occur among regionally-metamorphosed rocks; and (2) those which are closely associated with or intercalated among normal clay-slates. To the second group belong the deposits of the Rammelsberg (near Goslar), of Meggen on the Lenne, and of the Huelva district. Under the first group are ranged the numerous pyrites-deposits of Scandinavia, more especially those of the western coast of Norway, and, in fine, the great majority of known pyrites-occurrences all the world over.

The author proceeds to show that Prof. Vogt's assimilation of the Rammelsberg and Huelva deposits to those of Norway, as having all alike originated from "pneumatolytic dynamometamorphism" is mistaken. So far as the metallic minerals on the whole are concerned (exceptions will be mentioned later) all the deposits above enumerated show indeed such similarities as inevitably lead to the inference that they belong to one great common family; but the differences are enormous when we come to consider the variety of the non-metallic minerals associated with them. It is partly by means of these non-metallic minerals, that the history and genesis and the proper grouping of the various pyrites-deposits may be traced out.

Metamorphism did not generate pyrites-deposits: it found them ready-made, and altered them in common with the immediately neighbouring "country-rock." On this point the author's conclusions are again diametrically opposed to those of Prof. Vogt. In metamorphosed pyrites-deposits, the presence of magnetic iron-ore and magnetic pyrites points to intense heat as having been the chief agent of alteration: these minerals do not occur in the non-metamorphic pyrites-deposits.

The author has discussed on a previous occasion the metamorphic nature of magnetite, and here he devotes some space to the question of the genesis of magnetic pyrites by alteration of ordinary pyrites, being careful, however, to point out that not all magnetic pyrites is metamorphic. The "natural roasting" or "thermal metamorphism" of pyrites results (1) in magnetic pyrites; (2) if carried a stage further, in magnetite; and (3) if carried to a rare extreme, in specular iron-ore.

The quantity of magnetic pyrites and magnetite associated with a pyrites-deposit should, therefore, serve as a measure of the amount or intensity of metamorphism which that deposit has undergone: although such exceptions as the unaltered deposit of Sain-Bel, immersed in metamorphosed schists, must be borne in mind. However, the numerous non-metallic silicates associated with metamorphic deposits will, as before hinted, help to standardize the intensity of the metamorphism.

If the author's views are correct, they should serve to throw light on much that has hitherto appeared to some minds inexplicable in connection with ore-deposits, as, for instance, the mode of origin of the lead, zinc, and silver-ores of Broken Hill, that of the ores of Bodenmais in Bavaria, and of Ducktown in Tennessee, etc. L. L. B.

CONTACT-METAMORPHISM AND ORE-DEPOSITION IN SUMATRA.

Über Gesteinsumwandlung, hervorgerufen durch erzzuführende Processe (Beobachtungen an Gesteinen der Landschaft Ulu Rawas, Süd-Sumatra). By L. Milch. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*, 1904, *Beilage-Band xviii., pages* 452-459.

In the course of a study of the rock-collection, which represents the fruits of Dr. W. Volz's journey to Southern Sumatra in the years 1899-1901, the author came upon some very peculiar rocks, palpably associated with ore-deposits, and altered by the same processes as those which had brought the metalliferous particles into their present position.

The matrix of the pyrites- and galena-vein of Sungei Tubo, in the district of Ulu Rawas, is a pale-grey, highly altered porphyritic eruptive rock. The mode of distribution of the ores, their tendency in association with quartz to replace the felspars of the original rock, and the peculiar coloration of the mica, suggested that the ores had originated from the activity of fumaroles. Further investigation, however, showed that this hypothesis could only hold good to a very small extent. North-west of the vein, a dark, dirty-green rock crops out, with pyrites distributed very evenly throughout its mass, and careful study shows that it originated from the same eruptive magma as the (apparently) quite different rock just described. In the immediate neighbourhood of the ore-body there is abundant evidence of the secondary formation of quartz and sundry silicates on a large scale. The presence of garnets, both fresh and decomposed, within the ore-body itself, is also noted; as, too, the speckled sandy mass next the vein, consisting of partly decomposed cerussite, iron-hydrates, finely-fibrous hornblende, and a little quartz.

A cherty phyllite (?) in the river-gravel of the Sungei Nitap, exhibits fissures infilled with metalliferous ore, fine-grained quartz, and hornblende—the two latter constituents varying considerably in relative proportions. Investigation shows that what was originally a phyllite was metamorphosed into a hornfels-like rock simultaneously with the arrival of the metalliferous particles upon the scene. What exactly was the nature of the metamorphic process the available evidence fails to establish. L. L. B.

ANOMALIES IN THE EARTH'S DENSITY IN THE NEIGHBOURHOOD OF ETNA.

Sur les Anomalies de la Gravité et les Bradysismes dans la Région orientale de l'Etna. *By* GAETANO PLATANIA. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii.*, *pages* 859-860.

Prof. de Lapparent, in regard to the anomalies in the law of gravity, has already pointed out that these do not increase as we pass from a terrestrial to a maritime area, but may be associated with a particular region of dislocation at the contact of an area which is sinking (and is being squeezed up as it sinks) with an area which is either stable or in process of elevation. Now, the eastern district of Etna, where the variations of gravity are especially noteworthy, is not only subject to frequent seismic phenomena (often purely local) but is conspicuous for deep fissures in the earth's crust; and while one part of the area is in process of elevation, the other part is gradually sinking. The evidence for this simultaneous depression and elevation is adduced in detail, and it is shown how it coincides with the anomalies there observed in the law of gravity. L. L. B.

BAUXITE.

La Bauxite. *By* G. AICHINO. *Rassegna Mineraria*, 1902, *vol. xv.*, *Nos.* 15-18 (46 *pages*).

Premising that bauxite is now the most important source for the extraction of aluminium and its salts, the author points out that under one name it includes at least two distinct mineral species, one of which is a trihydrate (U.S.A.) and the other a dihydrate (France). He discusses at some length the analyses of bauxite which have been made on both sides of the Atlantic, and agrees with Mr. T. L. Watson, that the safest general chemical formula to adopt for the mineral is $Al_2O_3 nH_2O$. Its mode of occurrence is extremely variable, and it can hardly be said to possess any distinctive physical characteristic, unless that be its general pisolitic or concretionary form. In colour, it ranges from pure white to dark-red or even black; sometimes it seems to be a fine-grained, hard, compact rock, and sometimes it occurs as an earthy, clayey-looking substance.

The classic locality, which has given its name to the mineral, and where, until recent years, it was most extensively worked, is Baux in the department of the Rhône. There it is distinctly bedded, the strata varying in thickness from a few inches to 65 feet, and overlapping one geological formation after another, from the Infra-Lias to the Urgonian; the bauxite-deposits are overlain by rocks of Upper Cretaceous age. Mr. Francis Laur distinguished four types of bauxite in the French deposits; the other principal localities besides Baux being St. Chinian and Villeveyrac in Provence, Mende in the Lozère, and Pereilhes in the Ariège. The French analyses quoted by the author appear to show that the red or white varieties which are richest

in alumina and poorest in sesquioxide of iron contain more silica than the red varieties in which the above-mentioned iron-oxide abounds, but this conclusion is not of universal application.

After a short description of the important deposits in county Antrim, and a reference to those of Austria and Vogelsberg in Germany, the author proceeds to deal with those of his own country, Italy. The recent discovery in the Central Apennines of considerable occurrences of bauxite has aroused the attention of industrialists. The most important locality from this point of view is Lecce ne' Marsi, where a deposit about 10 feet thick covers an area of 250 acres or more on the western slopes of the Monte Turchio: the bauxite is generally interbanded with Urgonian limestones, and is finely oolitic, while amid its mass are "porphyritically" scattered numerous more or less mis-shapen pisolites. It is asserted that analyses privately made show the mineral to contain 60 per cent. or more of alumina, but certain analyses made by the author himself of specimens submitted to him, yielded a somewhat smaller average percentage (say, rather more than 57): even so, the mineral would be of fairly high grade.

A lengthy description, based on American publications, is given of the bauxites of Georgia, Alabama and Arkansas, with tables of analyses made in the United States, and this is followed by a discussion of the origin of bauxite-deposits generally; but the author refrains from committing himself to any particular view, in the present incomplete state of knowledge with regard to the actual number and extent of such deposits. He points out, however, that perhaps the true line along which to work towards a solution may be found in the analogy between bauxite and certain iron-ore deposits.

Between 1895 and 1899 the annual output in France, Great Britain, and the United States, increased from 47,633 metric tons in the former year to 93,754 metric tons in the latter year. Although the United States rank second as producers of bauxite, they import a considerable quantity from France as well, and it may be reckoned that about a quarter of the world's output of the mineral is utilized for the extraction of metallic aluminium. The various processes of this extraction are briefly described, and attention is then drawn to another use for bauxite which may assume great importance in the future, namely, as a refractory or fire-resisting material, in those cases where the mineral does not contain too large a proportion of silica and iron.

On the whole, this somewhat lengthy paper constitutes rather a summary of previous knowledge, than a contribution of new facts or results.

L. L. B.

ANTIMONY-ORES OF KŘITZ, BOHEMIA.

Zur geologischen Kenntniss des Antimonitvorkommens von Křitz bei Rakonitz. By Friedrich Katzer. *Verhandlungen der k. k. geologischen Reichsanstalt*, 1904, *pages* 263-268.

The antimonite-deposit near Křitz, a village 11 miles or so south of Rakonitz, was described as long ago as 1858. A fresh attempt was made to work it at the beginning of the 'nineties, but operations were soon suspended. However, the more recent excavations enabled the author to investigate the deposit more minutely than had been hitherto possible. The predominant rock of the neighbourhood is a greenish-grey phyllite, in places contact-metamorphosed by the eruptive "greenstones" (chiefly diabases) which

traverse it. But regional metamorphism (due, that is, to phenomena of pressure, etc.), has had perhaps the greatest share in determining the present structure of the rocks of this district. A great belt of calc-schist is interbanded with the phyllite.

The antimony-ore occurs at or near the junction of the altered phyllite with the diabase, in the form of a brecciated vein striking about south-south-west, and dipping steeply to the east-north-east. The ore is of considerable purity, picked samples yielding an average of 85 per cent. of sulphide of antimony, and some as much as 92 per cent. The gangue is chiefly quartz, sometimes containing crystalline druses, wherein the quartz-prisms are coated with a limonite-film. The associated "torsion-fissures" and numerous complicated slickensides point to considerable thrusting and grinding movements having taken place among the rock-masses in bygone ages.

Nothing is said in the paper as to the industrial importance of the deposit.

L. L. B.

THE HOŘENSKO-KOSCHTIALOW COAL-BELT, BOHEMIA.

Der Hořensko-Koschtialower Steinkohlenzug bei Semil in Nordostböhmen. By Friedrich Katzer. *Verhandlungen der k. k. geologischen Reichsanstalt*, 1904, *pages* 150-159, *with* 4 *figures in the text.*

In the Permian area on the south side of the Riesengebirge, besides bituminous shales, there occur coals which have been the object of rather spasmodic mining operations. The coal is of moderate quality, yields generally a great deal of ash, and the thickness of the seams rarely exceeds 20 inches. Some of the principal collieries were situated along a belt running east and west for several miles from Hořensko to Koschtialow-Œls, south of Semil, in North-eastern Bohemia, the coal-bearing beds occupying an anticline, which at a fault-line on the north is thrust over the Permian conglomerates and sandstones (Semil Group), while on the south the anticline is overlain by these conglomerates and sandstones. Intrusive sills of melaphyre are interbedded among the latter. The dip of the Permians is steep and almost uniformly to the south. The coal-seams have in some localities undergone an extraordinary amount of folding and squeezing, and the vertical section of the strata at one place is so different from that at another, that exact correlation of the seams is impracticable.

Another difficult problem is that of the age of the seams: to obtain sufficient evidence from the plant-remains it would be necessary to rake through all the old waste-heaps; but such evidence as there is points to a Carboniferous, rather than to a Permian, age. The author remarks, however, that it would be premature to consider the question as settled at present.

L. L. B.

THE MAGNETITE-DEPOSITS OF MALESCHAU AND HAMMERSTADT, BOHEMIA.

Die Magneteisenerzlagerstätten von Maleschau und Hammerstadt. By Friedrich Katzer. *Verhandlungen der k. k. geologischen Reichsanstalt*, 1904, *pages* 193-200, *with* 3 *figures in the text.*

These magnetites, which occur among the gneisses south of Kuttenberg, were actively worked until the middle of the last century, and since then

various unsuccessful attempts have been made to revive the mining industry in that neighbourhood. Of late, the near approach to the old mines of a new net-work of light railways has drawn attention to the possibility of a successful resumption of mining operations.

The gneiss-massif of Central Bohemia, which stretches southward from Kolin and Kuttenberg to the Sazawa river, is characterized by numerous intercalations of hornblendic rocks and granitic eruptives. The hornblendic rocks are of much more recent origin than the gneisses, and of still later date are the pegmatites, occurring in the form of bosses and innumerable dykes.

At Maleschau, the magnetite-deposit occurring on the Stimmberg plateau is intimately associated with hornblendic rocks, in which it is found in nests or with which it is interbanded. The purest ore always contains some hornblende and more especially garnet. The last-named mineral also occurs in considerable quantity, apart from the magnetite. That ore is mainly of magmatic origin, and was separated out from the original eruptive magma immediately after the apatite. Hornblende and (finally) felspar were separated out afterwards; but where garnet occurs felspar appears to be absent. The calcite, which generally impregnates the whole mass of the rocks, was probably derived from the overlying Cretaceous sedimentaries. Where garnet is the chief associate of the magnetite the latter occurs in finely-granular crystalline aggregates, but it is much coarser-grained when hornblende is its chief associate.

The geological conditions of the magnetite-deposit of Fiolnik or Fiovnik Hill, north-east of Hammerstadt on the Sazawa, are very similar, except perhaps that they are repeated on a larger scale. The magnetite is associated with the garnet-bearing hornblendite, but is rarely so finely granular as at Maleschau. Its chief impurity is hornblende, and the percentage of that is usually so small that the Fiolnik ore can be pronounced at the first glance as of high quality. For metallurgical purposes, however, it is best mixed with other iron-ores, with which view limonites were at one time worked in certain localities in the district. The old magnetite-workings of Fiolnik, as at Maleschau, were on the whole shallow, the deepest shaft having been sunk to a depth of 262 feet. L. L. B.

THE ROOFING-SLATES OF EISENBROD, BOHEMIA.

Der Dachschiefer von Eisenbrod in Nordböhmen. By Friedrich Katzer. *Verhandlungen der k. k. geologischen Reichsanstalt*, 1904, *pages* 177-182.

The slate-quarrying industry of Eisenbrod dates back to the first half of the nineteenth century, and although within the last decade the output has decreased considerably, it is still of economic importance, for the neighbouring district at least.

The phyllites north of the town, where the slate-quarries are situated, show greatly-disturbed bedding and are seamed by innumerable intrusive dykes (augite-rocks). The green roofing-slate occurs in lenticular masses among the phyllites, in such wise that 80 to 90 per cent. of the rock, that has to be quarried to get at the slate, must needs be tipped on to the waste-heaps. In some cases the quarry-owners have had to hew down rock for a twelvemonth before reaching a good bed of roofing-slate. These difficulties, naturally enhancing the cost of output, account for the decline that has set in since the end of the 'nineties.

The slate could be split up very thin, is of excellent quality, predominantly pale-green in colour, occasionally violet or blue, and of extremely-compact structure. As in many other occurrences of roofing-slate people distinguish between " dry " and " wet " slates, and therefore some of the Eisenbrod slate is best worked in the summer and some in the winter. The " winter-slates " are quarried night and day, as long as the frost holds. But when the slate has once been stacked and air-dried no difference can be detected, as between the two varieties. The best slate is exported to Saxony.

L. L. B.

GRAPHITE-DEPOSITS IN BOHEMIA.

Das Vorkommen von Graphit in Böhmen, insbesondere am Ostrande des südlichen Böhmerwaldes. By O. Bilharz. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 324-326.

Bohemia possesses two widely-separated groups of graphite-deposits, the one lying at the foot of the Saaz Mountains close to the Moravian frontier, and the other in the southernmost portion of the great Bohemian Forest. The latter group is both geologically and genetically connected with the Passau graphites of Bavaria.

In the Saaz district, the phyllites and slaty schists, especially where they are rich in pyrites, pass into graphite-slates. There is, moreover, an unmistakable genetic relationship between the occurrence of graphite and that of limestone-bands among the Archæan schists: five or six of these bands have been located in the Saaz area, and at their contact-surface with the schists, pure graphite is intercalated in lenticular masses, which seem to have bodily replaced schistose material. The graphite becomes harder as the depth from the surface increases, and finally passes into bedded graphite-slates. The most important deposits occur at Trpin, Wachteldorf, and at Predmesti, near Swojanow (where the graphitic deposit is seen to attain a thickness of about 40 feet).

Of far greater importance, however, both in regard to their extent and their regularity, are the graphite-deposits in the south of the Bohemian Forest. Starting at Schwarzbach, where they occur in association with limestone in lenticles among the gneisses, the deposits strike northward to Stuben, then eastward to Krumau, and finally due northward as far as the neighbourhood of Netolic. In the northern portion of this belt, the graphites occur rather in beds or seams than in lenticles, a whole succession of these seams following one on the other at short intervals. Exploration-work is at present concentrated on the township of Kollowitz, 12½ miles north-west of Budweiss: the thickness of the " seams " is found to vary from 16 inches to 6½ feet, roof and floor being in all cases made up of soft decomposed gneiss. Borings have proved the deposits over an area a mile and a quarter long, and rather less than 3 furlongs broad. Pure massive graphite is not found in the uppermost seams, but occurs only in the deeper-lying beds. However, the top bed is being methodically worked: it yields a blackish-grey pulverulent mass, consisting of innumerable graphite-flakelets, and this is ground up and separated by winnowing into coarse and fine " flour," etc. The annual output averages at present from 400 to 500 wagon-loads of saleable stuff, and is shortly to be increased to 1,000 wagon-loads. According to the statistics published by the Austrian Ministry of Agriculture, the graphite-mines of the district around Schwarzbach-Krumau

(in the southern portion of the belt) have a combined annual output of 1,200 wagon-loads. The selling price ranges between 27s. 5d. and 29s. 4d. per ton: and one gathers that, at such prices, the graphite-mining industry is very profitable. L. L. B.

THE PITCHBLENDE OF JOACHIMSTHAL, BOHEMIA.

Les Filons de Pechblende de Joachimsthal (Bohême). By R. D'ANDRIMONT. *Annales de la Société géologique de Belgique*, 1904, *vol. xxxi., Bulletin, pages* 91-93, *with* 1 *figure in the text.*

The search for minerals containing radium has now become a matter of widespread commercial importance, and so the author feels justified in stating briefly the results of a recent visit to the Joachimsthal mines. Premising that pitchblende is an extremely-complex mineral, containing, besides 40 per cent. of uranium oxide (UO_4), arsenic, molybdenum, sulphur, tungsten, vanadium, silver, lead, bismuth, magnesium, calcium, iron, aluminium, cobalt, nickel, silicium, and carbon dioxide, he says that the veins of it in the locality described are only 1 or 2 inches thick. They occur in a belt largely made up of biotite-schists, abutting on the west against a granitic massif: the country is traversed by two main systems of fissures, which cross one another at right angles. Those striking northward and southward are metalliferous, while the east-and-west fissures are barren. The earliest eruption was that of the granite, followed by porphyry, then came the metalliferous veins, and thereafter a flow of basalt closed that chapter of geological history. The uranium-mineral occurs exclusively in the biotite-schists, and the gangue is invariably dolomite, with a large proportion of other mineral-substances. These indications are perfectly well known to the Joachimsthal miners, who make use of them in looking for new occurrences of pitchblende.

It seems possible that the uranium first made its appearance in the form of a carbonate, which reacted with the magnesium of the biotite; indeed, it is noticeable that the biotite-schist is altered at the contact of the veins. A further inference is that, in a vein apparently consisting of dolomite alone, pitchblende may well be found to occur deeper down. L. L. B.

GLAUBER'S SALT IN THE TRIAS OF BOSNIA.

Über ein Glaubersalzvorkommen in den Werfener Schichten Bosniens. By FRIEDRICH KATZER. *Centralblatt für Mineralogie, Geologie und Paläontologie*, 1904, *pages* 399-402.

In cutting the Jahorina tunnel (3,100 feet above sea-level) on the new railway from Sarajevo to the eastern frontier, a seam of impure brownish-black coal, only 2 inches thick, was found among the red Werfen Beds (equivalent to the Bunter Sandstone). Below the coal (which is the second known occurrence of the kind in the Werfen Beds of Bosnia) the first deposit of Glauber's salt was struck, in the form of a lenticle barely 4 inches thick; a few yards farther on, another deposit, about 3 inches thick, was discovered. The strata with which these deposits are interbedded are red, highly-micaceous clay-slates, but the Glauber's salt-bands are immediately overlain and underlain by a dark-brownish red micaceous clay. The Glauber's salt is

colourless, water-clear, non-crystalline, with conchoidal fracture. The deposits doubtless owed their origin to the same processes as those now going on in the shallow bays of the Caspian, where similar deposits are being laid down.

Nothing is said as to the possible industrial bearing of the discovery.

L. L. B.

PETROLEUM-DEPOSITS OF THE PUTILLA VALLEY, BUKOVINA

Über die Rohölführenden miocänen resp. oberoligocänen Schichten des Thales Putilla in der Bukowina. *By* Dr. Stanislaw Olszewski. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 321-324, *with* 1 *figure in the text.*

The Putilla is a tributary of the White Czeremosz River, which forms the boundary between Galicia and Bukovina. The views held in regard to the geology of the district were so conflicting, that the author, when he journeyed thither in May, 1904, in order to examine into its possibilities as a natural oil-reservoir, felt bound to exercise more than ordinary care in the investigation. In the Putilla valley, he found no trace of Cretaceous or Eocene rocks, nor any of the Upper Oligocene menilite-shales; but the high ridges of Rakova and Krasny-Dil, which wall in the valley, are mainly built up of Magura Sandstone, the massive beds of which dip north-eastward. The author has, on previous occasions, drawn attention to the importance of the Magura Sandstones or Dobrotow Beds, in connection with the occurrence of petroleum. It was because they had overlooked this point, that so recently as 1898, the Carpathian geologists declared what now proves to be the richest oilfield in Galicia, to be worthless from the petroleum-seeker's point of view. The western portion of the Putilla valley exhibits greater irregularity of configuration: the strike of the beds varies considerably, and they are much disturbed and faulted. The strata here are predominantly grey shales, with which are interbedded thin, micaceous fucoid-sandstones; and secondarily the saline clays (which form so characteristic a horizon in Galicia) make their appearance. All the beds mentioned belong to the Upper Oligocene-Miocene succession. The author discusses at some length the tectonics of the area, and then enumerates the localities where traces of petroleum have been recorded. At Dichtenitz, some 30 years ago, 5 barrels per day are said to have been got (from a well, 105 feet deep) of a pale-green oil, rich in paraffin, solidifying above the well-water into a green substance known as *kindibal* (intermediate between crude oil and ozokerite). Oil has also been got at three localities around Sergie, and at one point it would seem possible to correlate the oil-bearing bed with that of Dichtenitz. In view, however, of the extremely-broken character of this mountainous district, no such definitely-continuous oil-horizons as in Galicia can be looked for. The fact, however, that oil has been struck at such shallow depths in the Putilla valley admits of the expectation that richer oil-bearing beds will (as in Galicia) be struck at greater depths. The enormous development of the Magura Sandstones is also an encouraging indication. The nearest railway stations (Wisnitz and Brodina) are from 25 to 37 miles away; timber, both for structural purposes and for fuel, is cheap. The local labourers are skilful carpenters, but it is doubtful whether they would make good well-sinkers.

L. L. B.

THE BORYSLAV OIL-FIELDS, GALICIA.

Notiz über das geologische Profil durch die Ölfelder bei Boryslaw in Galizien. By CARL SCHMIDT. *Verhandlungen der Naturforschenden Gesellschaft in Basel*, 1904, *vol. xv., pages* 415-424, *and* 1 *plate*.

This paper and the accompanying section are the outcome of a journey which the author made to the petroleum-fields of Eastern Galicia in the summer of 1903. He gives a bibliographical list of the works consulted by him, beginning with 1877 and closing with 1904, and points out that the Boryslav and Schodnica districts are now reckoned among the richest oil-producing areas in Galicia. The annual output from the Boryslav district alone averages 480,000 tons of petroleum and 2,000 tons of ozokerite. In the Mraznica and Schodnica districts also industrial activity has increased enormously of late: the wells in the former of these two have yielded a steady, if not a very abundant, output of oil for the last 35 years.

The strata richest in oil are mainly associated with the secondary anticlinal folds, embraced in a huge highly-faulted Eocene-Oligocene syncline. Two horizons in the Eocene, and a third in the *Inoceramus*-beds (Cretaceous) are said to yield the greatest quantities of petroleum. The overthrusting and overfolding of the rocks are briefly touched upon, and it is pointed out that the most recent oil-bearing horizon in Galicia is the Saline Clay, of Miocene age. The remark is here interjected that the sub-Carpathian Miocene is known to be a great reservoir of oil in Rumania. Petroleum is got from the Saline Clay along a belt of 12 miles or more in the neighbourhood of Boryslav, and also at Bolochov and Solotvina to the south-east. The Boryslav oil, down to a depth exceeding 1,970 feet, contains from 6 to 10 per cent. of paraffin—and there seems to be no doubt that there is a causal connection between the presence of bands and layers of ozokerite and this amount of paraffin. Ozokerite usually occurs at depths not exceeding 850 feet or so below the surface, but has actually been struck at a depth of 2,280 feet. The question of the origin of mineral wax appears to belong to the domain of chemistry; but it may be gathered that the author's own observations in Eastern Borneo (where occasionally there is so much ozokerite floating about in the petroleum that the delivery-pipes are stopped) incline him to favour the hypothesis that the wax is the residue of an evaporation, unaccompanied by oxidation, of oils rich in paraffin.

In the Carpathian region, as in other oil-fields all over the globe, the proper application of the old anticlinal theory is of great importance from the practical point of view; in confirmation of which the author cites his experiences in Sumatra and Borneo, where all the borings for oil put down in accordance with that theory were successful. He points out finally that the Galician literature of the subject is unfortunately so taken up with polemics on stratigraphical questions, and theories concerning the origin of petroleum, as to crowd out much wished-for information, such as exact sections of the borings, etc. L. L. B.

THE PETROLEUM-BELT OF SCHODNICA, EASTERN GALICIA.

Die geologischen Verhältnisse der Erdölzone Opaka-Schodnica-Urycz in Ostgalizien. By DR. RUDOLF ZUBER. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 86-94, *with* 9 *figures in the text.*

The author shows in the introduction that he has had quite exceptional opportunities, during many years, of making himself thoroughly acquainted

with the geology of the district of which he treats. He describes briefly the rock-formations in ascending order, beginning with the Lower *Inoceramus*-beds or Ropianka beds of Neocomian age, passing on then to the upper *Inoceramus*-beds (or Gault), and the Jamna Sandstone (or Upper Cretaceous). These are followed by the Eocene clay-slates and conglomerates, and the menilite-shales of Lower Oligocene age, which latter are characterized in that particular district of the Carpathians by a prominent basement-bed of chert. Apart from drift and alluvial deposits, these menilite-shales are the most recent formation in the area, which is one of great tectonic disturbance, and is traversed by numerous folds and fissures striking generally north-west and south-east.

The geological structure of the district is described in some detail, much of the evidence being obtained from the numerous borings put down there for petroleum. Two chief oil-bearing horizons are recognized and worked in the Eocene formation, but the author feels no doubt that a third oil-bearing horizon will be struck ere long, this time, however, in the Lower Cretaceous. The most suitable locality to search for this probably productive horizon would be on the Pasieczki estate, the one drawback being that it will be necessary to go through the water-logged Jamna Sandstone before getting down to the indicated horizon.

The main oil-horizon in the north-western portion of the belt, towards Opaka, is almost untouched as yet, and industrial prospects here are very promising. The area to be worked covers at least 296 acres. Although the menilite-shales contain much bitumen, and fish-remains in abundance, nowhere in this district do they yield petroleum. Repeated search in them for oil has proved fruitless. The author concludes that the Eocene petroleum of this area occurs in the actual place where it was formed, and points out that no other conclusion is possible, in presence of the evidence which he has adduced. The entire length of the belt, from Opaka through Schodnica to Uryez, is about $7\frac{1}{2}$ miles, and the average breadth is 1,300 feet or so,—the total workable area would therefore be about 1,186 acres, of which (as above-mentioned) 296 are still unworked. The year 1900 was the culminating-point in regard to output, which has since then tended to decrease. About 450 wells are yielding oil. L. L. B.

THE OZOKERITE-DEPOSITS, ETC., OF BORYSLAV, EASTERN GALICIA.

Die geologischen Verhältnisse von Borysław in Ostgalizien. *By* Dr. Rudolf Zuber. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 41-48, *with* 4 *figures in the text.*

In view of obviating the errors which necessarily attach to wide geological conclusions based on isolated observations, the author now puts forward his own results: these do not agree with those of certain writers whom he quotes, and he states that his conclusions are the fruit of a long-continued careful study of the Boryslav area.

The town of that name lies close to the north-eastern margin of the Carpathians, almost midway between the valleys of the Dniestr and the Stryj, at the point where the stream called the Tysmienica issues from the mountains. The outermost range of the Carpathians trends here nearly due north-west and south-east, the boundary between it and the pre-Carpathian foothills being well-marked: in point of fact, it delimits the overthrust of

the older Carpathian formations over the younger strata peculiar to the foothills.

The strata are described in descending order. First come alluvial and diluvial loams and gravels, in places very thick. Underlying these drifts are the ashen-grey Lower Miocene saline clays, with which are interbedded sandstones of varying texture, often containing ozokerite, natural gas, oil and carbonized plant-remains. Great rolled blocks of Eocene and Cretaceous limestones, etc. are irregularly distributed throughout the formation. Clays and sandstones alike are rich in gypsum and rock-salt, and brine-springs are very frequent. Government salt-works are still in existence at Drohobyez (5 miles north-east) and at Stebnik (5 miles east) of Boryslav. In the same formation, blende, galena, and native sulphur have been recorded at Truskawiec; and at Pomiarki an important deposit of pure Glauber's salt has been struck. The salt-formation is probably not of marine origin, but was laid down in one or more lake-basins under desertic conditions.

Ozokerite occurs, both in layers and as infillings of fissures: there is no question as to its occurrence in bedded layers, despite official theories to the contrary, but it is true that these layers are thin, and often pinch out. The greatest masses of ozokerite are concentrated in veins, nests and fissures. In the northern portion of the district the richest fissures, dipping steeply northward, have been opened up to a depth of about 1,000 feet below the surface; but in deep borings for petroleum more to the south, considerable masses of ozokerite have been found at depths as great as 2,300 feet.

The tremendous pressure of the strata in the Boryslav workings is notorious: the strongest timbering is snapped up like matchwood, whole shafts are twisted out of the perpendicular, boring-rods are flattened like straws, and yard-long ribbons of ozokerite are suddenly squeezed out of the fissures, in company with shapeless masses of rock-salt.

The plasticity of the entire formation and the recklessly-unmethodical fashion in which it was worked for many years have had the inevitable result, that the chief mining area is continually in motion: thus, too, the upper part of the salt-formation is in a state of chaos, in places completely turned upside down, to a depth of as much as 330 feet. The petroleum which occurs in the western portion of the district is very rich in paraffin, viscous, and blackish-brown in colour; in the eastern division (Tustanovice-Volanka), on the other hand, it is a considerably lighter and paler oil, and rich in benzine.

Next below the salt-formation comes a group chiefly of sandstones and conglomerates, which the author correlates with the Magóra Sandstones of Upper Oligocene age, and terms the Dobrotov group. The compact, argillaceous and micaceous sandstones are characteristically ripple-marked, and with them are interbedded narrow bands of dark shale: they are often full of carbonized plant-remains, and constitute the richest horizon for petroleum in this area. At Boryslav itself, they do not crop out at the surface, but an excellent exposure is seen $7\frac{1}{2}$ miles away to the north-west, at Nahujovice. On boring down to the underlying Lower Oligocene menilite-shales these are found to be barren of oil, as they are, indeed, almost everywhere in the Carpathian region. With the progress of boring operations and the continual advance in technical matters, we may expect that the lower limit of the oil-bearing strata will be everywhere reached in the Boryslav district. It must be remembered that with the menilite-shales are associated water-bearing sandstones, and carelessness in conducting boring operations might conceivably result in the flooding-out of the overlying oil-horizons from these sandstones.

With regard to the output of oil, it amounts roughly to 40,000 tons a month, but it is very unevenly distributed, on account of the rapid alternation of rich and poor or even barren "ground." Towards the north-east (Volanka) the wells diminish continuously in yield, and finally the productive strata are abruptly cut off by what may be either a fold or a fault—a matter which still awaits investigation.

Below the menilite-shales are the Eocene red and green mottled slates and shales, with the lower beds of which especially are interstratified sandstones and conglomerates. These constitute in part the Carpathian Sandstone Series, and are known to be one of the most important oil-bearing formations in the Carpathian region. It seems, therefore, probable that deep below the strata now worked for oil at Boryslav yet another petroleum-reservoir lies untouched. The possibility of tapping it, however, is confronted by the necessity of boring to a minimum depth which might be anything between 5,000 and 6,500 feet, and of passing through the above-mentioned water-logged sandstones on the way down.

The author's diagrams illustrate the folding and faulting which have disturbed the strata in the district described, and he devotes the latter portion of his memoir to the vexed question of the origin of the ozokerite and petroleum. He regards both as primarily derived from vegetable organisms, the detritus of a luxuriant tropical flora. L. L. B.

COAL-FIELDS OF HUNGARY.

Die Mineralkohlen der Länder der Ungarischen Krone. By Alexander von Kalecsinszky. [*Official publication, Budapest*, 1903], 324 *pages* 8*vo*, *with* 3 *figures in the text, and* 1 *map.*

We learn from the introduction to this work that the first memoir of any importance dealing with Hungarian coal was published in 1839. Since then the development of the mineral industry and the knowledge of the mineral resources of the Magyar kingdom have made great progress, as exemplified in the author's exhaustive survey. To his book has been awarded the prize of 1,000 florins founded by the Hungarian Natural History Society in 1892. He examined a vast number of specimens of coal, and tested their heating-power. No less than 22 pages are devoted to a description of his methods of analysis, and of the manner of using the Berthelot-Mahler calorimeter.

The only seams belonging to the Carboniferous system occur in the county of Krassó-Szörény. In the Permian a few unworkable seams are found, but the Liassic and Oligocene (older Tertiary) are the most important coal-bearing formations in Hungary. The Cretaceous coals are also of economic interest, and so too are the lignites and brown coals of the Neogene (newer Tertiary) groups. A full catalogue is given of the localities where coal is worked, with the number of workpeople employed in each case, and the average output. It may be noted that the total coal-output of the Hungarian kingdom steadily increased from 1,500,000 tons in 1875 to 5,500,000 in 1899: the proportionate increase of the Austrian output was not nearly so great. This catalogue is followed by a bibliography extending over 8 pages, and that again by a description of the various seams, with analyses of the coal, etc., arranged alphabetically under place-names. This, in fact, constitutes a sort of topographical dictionary or "coal-gazetteer," in

which all the available information as to quantity and quality, methods of working, stratigraphy, etc., is concentrated. There are many useful cross-references, and it certainly appears as if no locality where coal has been actually found in Hungary is left undescribed. An appendix contains analyses of Bohemian, Moravian, Silesian, and other coals, for comparison with those of Hungary. L. L. B.

MANGANESE-ORES OF DOLINA, ISTRIA.

Manganerzvorkommen von Kroglje bei Dolina in Istrien. *By* Dr. L. Karl Moser. *Verhandlungen der kaiserlich-königlichen Geologischen Reichsanstalt*, 1903, *pages* 380-381.

Chemical analyses of certain mineral-specimens sent to the author by the mayor of Dolina having revealed the presence in that neighbourhood of manganese-ores, the author proceeded to make an investigation on the spot in the latter part of 1903. The locality is situated at an altitude of about 650 feet above the small hamlet of Kroglje, some 3 miles distant from Borst station on the Istrian State Railway. Here a limestone-breccia, derived from the Cretaceous escarpment which towers above the Eocene sandstones of the valley, occurs in a highly-weathered condition, mostly altered into brown hæmatite, and is in places quite crumbly. Some experimental diggings which the mayor of Dolina had caused to be made brought to light thin bands of what is probably pyrolusite, passing by all sorts of gradations into limonite; among these is a pisolitic ore, the grains of which are uniformly of the size of poppy-seeds. The silica present in all the samples analysed is undoubtedly derived from the adjacent fossiliferous Cretaceous limestone. Nothing is said as to the industrial importance of the occurrence, except that, if the bands or veins of manganese-ore continue and thicken in depth, they might repay working. L. L. B.

IRON-ORES OF THE ERZBERG, STYRIA.

(1) *Der steirische Erzberg.* *By* A. F. Reibenschuh. *Mittheilungen des Naturwissenschaftlichen Vereins für Steiermark*, 1903, *vol. xl.*, *pages* 285-321.

The Erzberg, lying between the localities of Eisenerz and Vordernberg, belongs to the great belt of grauwackés which strikes east and west through the Austrian Alpine territories of Styria, the Salzkammergut and Tyrol. A series of iron-ore deposits, the most considerable of which is that of the Erzberg, characterize the basal portion of the grauwackés. The main ore-body is no less than 490 feet thick, with a height exceeding 2,132 feet: in the lower portion of the mountain the beds lie comparatively flat, while in the upper portion they are thrust up on end. Isolated on three sides by streams running in deep-cut gorges, the Erzberg has the form of a cone, standing clear of the steep ridges with which it is connected on the south-east by the *col* of the Platte. Ore has been mined there since time immemorial: it was with this Styrian iron that Celtic warriors, and then the Romans, fashioned their weapons, but the more continuous history of the mining industry on and around the Erzberg begins with the early Middle Ages, and is carried by the author down to the present day. Operations are now concentrated in the hands of a powerful syndicate, who have abandoned the system of underground workings (all the ore being got at present by gigantic opencast workings). Everything is done on a big scale,

by the most modern methods, and a narrow-gauge electric railway runs from the Erzberg to the single-track line (completed in 1891) built between Eisenerz and Vordernberg. Instead of the old charcoal-furnaces, most of which have been blown out, great new blast-furnaces, burning coke, have been erected at Donavitz and Eisenerz, and yield an output of pig-iron such as had never been dreamt of in the district. Although the average amount of ore got yearly has increased twelvefold within the last 30 years, the amount still in sight is reckoned to last for centuries to come.

The rock-succession consists, in ascending order, of (1) the Blasseneck Gneiss, the oldest formation in the district; (2) the unconformably overlying Lower Devonian limestones, etc.; (3) the Ironstone Series, made up of well-bedded, pale-grey or yellow, pure, small-grained, spathic iron-ores, with which are occasionally interstratified thin bands of impure pinkish limestone. Pale to mottled or dark micaceous clay-slates form the normal basement of this series, the actual age of which is unknown: all that can be said is that it is certainly newer than the Lower Devonian, but older than the lowermost Trias; (4) Werfen Slates [Triassic], red or greenish-grey sandy slates of enormous thickness, with much breccia and conglomerate at the base. The Werfen Slates are denuded away from the western portion of the district, in which, therefore, the great ore-mass is laid completely bare.

Among the minerals of the Erzberg, the chief part is played by the spathic iron-ore or siderite, termed *flinz* or *pflinz* by the local miners. The coloration varies through all shades from yellowish-grey to dark-brown, according to the degree of weathering. The portions of the ore-body nearest the surface are frequently decomposed to limonite, owing doubtless to the action of percolating waters from the surface. Ankerite is the most usual associate of the spathic iron-ore, and calcite and aragonite are of very common occurrence. A combination of the two last-named minerals in alternating tabulae, found only in one fissure in the deposit, received in 1891 the name of Erzbergite. Pyrites is found pretty frequently, but native sulphur, arsenical pyrites, cinnabar, galena, etc., are comparatively rare.

The output of ore in 1903 amounted to 482,543 tons, and that of pig-iron from the five furnaces in blast to 144,446 tons.

The paper is accompanied by a bibliography of the subject.

(2) *Le Gisement de Fer Spathique de l'Erzberg, près Eisenerz, en Styrie.* By J. Taffanel. *Annales des Mines*, 1903, *series* 10, *vol. iv.*, *pages* 24-48, *and* 2 *plates*.

The author begins by observing that the spathic iron-ore of the Erzberg, near Eisenerz, is one of the most extensive and one of the most productive of the kind in the whole world. It was worked by the ancient Romans, and mining operations have been carried on in unbroken sequence from the Middle Ages down to the present day, the development having been especially great during the last half-century. The average annual output exceeds a million tons, and at that rate working may go on for centuries yet without exhausting the reserves of ore now in sight.

The deposit is certainly pre-Triassic in age, probably Upper Silurian or Lower Devonian: it occurs in the upper part of a very complex group of shales, grauwackés, and limestones—the stratigraphy and exact succession of which has given rise to considerable discussion. The ore is mainly a spathose carbonate of iron, sometimes associated with a decomposition-product in the shape of limonite. The miners give the name of *rohwand* or ankerite to a limestone too poor in iron to repay working, and there is every gradation

from a rich ore to a perfectly-barren limestone. Thus far had the researches of Messrs. A. von Schouppe, D. Stur and E. Suess conducted geologists, when in 1900, Mr. Vacek published the results of a detailed investigation which he had made 14 years previously. He showed that there were great unconformities in the supposedly-homogeneous group of grauwackés, etc., and referred the components of that group to four different periods. The main iron-ore deposit he regarded as of Permian age, although he still assigned some of the ore-beds to the Lower Devonian, and he pointed out as one of the characteristic features of the Permian deposit, the absence of limestone. The exposures revealed in the cuttings of the Eisenerz-Vordernberg railway, constructed in 1889-1890, three years after Mr. Vacek's visit, yield, however, evidence which does not fit in with his conclusions. The ore-deposit must still be regarded as of more remote geological age, and of greater extent than he supposed. It is probably of metasomatic origin; whereas if Mr. Vacek's hypothesis were correct, the deposit would be of purely sedimentary origin. The author does not appear to claim that, even now, the last word in this discussion has been said.

(3) *Das Eisensteinvorkommen zu Kohlbach an der Stubalpe.* *By* Dr. Richard Canaval. *Berg- und Hüttenmännisches Jahrbuch der k. k. Bergakademien zu Leoben und Přibram und der kön. ung. Bergakademie zu Schmeczbánya (Schemnitz)*, 1904, *vol. lii., pages* 145-158, *with* 1 *figure in the text.*

The Kohlbach deposit consists chiefly of spathic iron-ore intermingled with, and passing into, crystalline limestone, and assuming the appearance of a bedded deposit. Garnet-mica-schists overlie conformably the group of ore-bearing rocks: an important member of this group is the yellowish-grey, banded micaceous quartzite, the chief constituent of the waste-heaps of the old mine-workings.

This ore-deposit, like that of the Hüttenberg, seems to have originated from metasomatic replacement of the limestone in the course of post-volcanic processes. It was worked towards the end of the eighteenth century, and again in the middle of the nineteenth, but mining operations were subsequently abandoned, as the quantity of available ore was not sufficient for a metallurgical industry on anything approaching a large scale.

The author devotes most of his paper to a detailed mineralogical description of the immediately-associated rocks. L. L. B.

ORE- AND MAGNESITE-DEPOSITS OF THE STYRIAN ALPS.

Ueber das Alter und die Entstehung einiger Erz- und Magnesitlagerstätten der steirischen Alpen. *By* Karl A. Redlich. *Jahrbuch der kaiserlich-königlichen Geologischen Reichsanstalt*, 1903, *vol. liii., pages* 285-294, *and* 4 *figures in the text.*

The conviction that a great number of the "bedded" ore-deposits did not originate at the same time as the adjacent "country-rock" is yearly gaining more adherents, and the author proceeds to adduce confirmatory evidence in favour of that opinion from the Styrian deposits. Thus the pyritic ores of Kalwang, Eblarn and the Veitsch, although apparently interbedded with hornblendic schists (metamorphosed diabases) are shown to be of later origin than these. Intimately associated, from the stratigraphical point of view, with the pyrites-deposits just mentioned are the siderites and ankerites of the Northern Alps, among which the author's most recent researches have

been conducted. He quotes the Siluro-Devonian complex of limestones and slates of the Zeyritzkampel, among which occur copper-pyrites, fahlores, ankerite, less commonly siderite, and still more rarely cinnabar. He proposes later on to devote a monograph to the probable output and practical value of these deposits: meanwhile he points out that one characteristic feature is the intimate intermixture of the above-mentioned ores. The junction between ankerite and limestone is irregular, and the former seems to have invaded the latter after its deposition; but the pyritic invasion of the limestone was a still more rapid process than the ankerite-invasion; in fact, over the whole area of this portion of the Styrian Alps, from the Radmer to the Johnsbach valley, the various ores are shown to have invaded and impregnated the limestones, and in some cases the neighbouring slates as well. Just as siderites are seen to pass into ankerites, so the latter pass into magnesites by way of dolomite. All over the area described, carbonates of iron are associated with the sulphidic ores; and the general conclusion is that the deposits cannot be regarded as true beds, laid down simply by the ordinary processes of sedimentation, but that they are the outcome of the metamorphism of the pre-existing materials. On a period of submarine eruption appears to have followed a period of normal formation of clastic sediments, attended by the usual phenomena of moribund vulcanicity, gaseous exhalations and thermal springs; and these constituted the metamorphic agent that partly converted the pre-existing rocks into ore-deposits. In regard to age, the oldest are the pyritic ores of Kalwang and Œblarn; next come the Siluro-Devonian iron- and copper-ores of the Radmer, the Erzberg, and the Hintere Veitsch; and finally the Carboniferous deposits of the Dürsteinkogel. L. L. B.

THE CAMPINE COAL-FIELD OF NORTHERN BELGIUM.

Considérations géométriques sur le Bassin houiller du Nord de la Belgique. By Émile Harzé. *Annales de la Société Géologique de Belgique*, 1903, *vol. xxxi., Mémoires, pages* 31-86, *with* 2 *figures in the text and* 2 *plates.*

The author, first of all, describes and figures the probable shore-line of the ancient Coal-measure gulf from Aerschot (south-east of Malines) to the Dutch boundary. This raises at once the question as to how near Antwerp the Coal-measures may be expected to occur, and borings have been put down to determine this point. At Santhoven, in December, 1902, two coal-seams were struck at a depth of about 2,300 feet, near the supposed edge of the basin; at Kessel on the other hand, south of Santhoven, the Carboniferous Limestone was reached at a depth of only 1,860 feet or so. But at Vlimmeren, north-east of Santhoven, the Coal-measures were struck, in August, 1903, at a depth of 2,939 feet: the boring was carried down to 3,372 feet, traversing four very thin seams of coal (3 to 8 inches each). The author thinks that at Vlimmeren there is a concealed ridge, separating two Coal-measure synclines.

He gives detailed tables of the various borings that have been put down in the newly-discovered coal-field, and discusses at some length such problems as the richness of the seams at different horizons, the limits of the barren belts, the probable course of the faults (a remarkable one has been recorded at Beeringen, where rock-salt and red marls were struck at a considerable depth); and then returns to the question of the possible prolongation of the coal-field north of Antwerp. As he believes that the general trend of the formation will ultimately prove to be towards the great

Yorkshire basin, he decides negatively in regard to the existence of workable Coal-measures in that particular portion of Eastern Flanders. The latest borings have done much towards determining the boundaries of the new coal-field, and have thereby reduced to more moderate proportions the extravagant anticipations which were formed regarding it a few years ago. Rich it is, nevertheless, and the Belgian Government are once again urged to reserve a portion of it for working by the State. L. L. B.

IRON-ORES IN THE CAMPINE COAL-FIELD, BELGIUM.

Découverte d'un puissant Gisement de Minerais de Fer dans le Grand Bassin Houiller du Nord de la Belgique. By G. LAMBERT. *Brussels*, 1904, 24 *pages and* 11 *plates.*

The first half of this pamphlet is almost entirely taken up with a disquisition on the working and gradual exhaustion of the blackband ironstones of Staffordshire, and the similar exhaustion of the iron-ores formerly worked in the districts of Liége, Charleroi and Mons.

The author points out that the output of Cleveland iron-ores, which for many years compensated England for the decline of the Staffordshire iron-mining industry, is itself rapidly diminishing; further, that the reputedly-inexhaustible deposits of Bilbao are showing signs of decline, and that the same statement holds good of the Algerian magnetites.

The author then describes the six borings which he and his son Paul (with others) were concerned in putting down—the first three in 1900 near Sittard on the right bank of the Meuse, and the other three near Lanklaer, Leuth and Eysden respectively, on the left bank of the same river. (Six plates are devoted to the borings put down in Belgian territory.) All these struck the Coal-measures at depths varying from 920 to 1,810 feet. The author points out that the announcement of a mining concession, sought by him and his partners near Sittard, was published by the Dutch Government in May, 1901, six months before the first mining concession was announced on the Belgian side of the river. The specimens got from the cores show, according to the author, that over a thickness of several hundred feet, ironstones, practically identical with the Dudley blackband, are conformably interbedded with the Coal-measures. Various analyses of the ore made in Paris, Bonn and Berlin have yielded from 30 to 40 per cent. of metallic iron, and from 0·55 to 7 per cent. of manganese. After calcination the ore assumes magnetic properties. The blackbands appear to increase in number and richness as the depth from the surface increases.

A new boring at Saerbeeck has recently struck thick seams of excellent coal at a depth of 3,936 feet. On the whole, the author believes that the new Campine coal-field is sufficiently rich and extensive to guarantee Central Europe against a shortage of coal for a long time to come. L. L. B.

POSSIBLE EXTENSION OF THE LIÉGE COAL-FIELD.

Le Prolongement de la Faille eifélienne à l'Est de Liége. By P. FOURMARIER. *Annales de la Société géologique de Belgique*, 1903, *vol. xxxi., Mémoires, pages* 107-136, *with* 14 *figures in the text and* 1 *plate.*

The author has devoted much time and care to the study of the prolongation, east of Liége, of the great Eifelian fault, which brings the Liége Coal-

measures against the Upper Coblentzian (Devonian) slates and quartzites. He describes in detail the results of his mapping, and shows that in the region studied by him, the accentuation of the folding movement gave rise to reversed faults of comparatively-low hade, dipping southward. He concludes that a great mass of Devonian and Lower Carboniferous strata has been thrust over the Coal-measures, concealing these over a considerable area. Whether they can be struck at anything short of very great depths, and whether they will prove workable even if struck at a reasonable depth, can only be determined by boring operations.

It will be remembered that, in the North of France, Coal-measures have been found far to the south of the southern boundary-fault; and in Hainault patches of Coal-measures have been discovered, faulted away miles to the north of that coal-field. In the Swiss Alps, to which the highly-folded region studied by the author bears a tectonic resemblance, overthrust masses have been traced more than 60 miles away from their original position. From these analogies, we may infer the probability of a more or less deep-lying extension of the Liége coal-field. L. L. B.

GALENA IN THE BELGIAN COAL-MEASURES.

Découverte d'un Filon de Galène dans le Terrain houiller du Bassin de Charleroi. *By* J. Smeysters. *Annales de la Société Géologique de Belgique*, 1903, *vol. xxx*, *Bulletin*, *pages* 120-122, *with* 1 *figure in the text.*

In the Amercoeur colliery, at Jumet, in the Charleroi basin, a grit (at the 2,300 feet level of the Bellevue pit) is traversed by a vertical fissure, about a couple of inches wide, which, in its lower portion, contains galena. The ore is perfectly crystallized in cubes, and appears to be very pure; with it is associated a small quantity of blende. It has also been found in a sort of pocket in the floor of the gallery: a certain amount of water welled out of this "pocket" as soon as it was struck, and from the above-mentioned fissure there is at present a flow of 1,300 to 1,700 gallons of water every 24 hours. As a heading is being driven in the rock below the 2,300 feet level and is likely to cut the fissure at a greater depth, further light will be thrown on the extent and possible importance of the metalliferous vein. At all events, this is believed to be the first-recorded occurrence of galena in the Coal-measures of Hainault. L. L. B.

MINERALS FOUND IN THE BELGIAN COAL-MEASURES.

Sur des Minéraux du Terrain houiller de Belgique. *By* X. Stainier. *Bulletin d la Société Belge de Géologie, de Paléontologie et d'Hydrologie*, 1904, *series* 2, *vol. viii.*, *Procès-verbaux*, *pages* 173-177.

Three new localities for the occurrence of blende are described: namely, (1) the Burton colliery, at St. Georges, where in a hard grit forming the floor of the Flairante coal-seam, a band of whitish-grey quartzite, very like gannister, is traversed by veins of crystalline quartz in which are embedded big transparent crystals of blende. The zinc-ore deposits worked by the same company as that which owns the colliery (Société de la Nouvelle Montagne) are close at hand, at La Mallieue, on the southern rim of the coal-basin; (2) in No. 1 pit of the Ressaix colliery, a much dislocated mass of grit intervenes between the Louise and Sans-nom coal-seams: it is traversed

by fissures about 1 inch wide, forming miniature metalliferous veins, the infilling consisting of successive bands of pyrites, blende, and yellow calc-spar: (3) in the Biquet-Gorée colliery, blende is found in quartz-veins which traverse a hard grit forming the floor of the Belle-et-Bonne coal-seam. This seam is the equivalent of the Flairante seam previously mentioned, and the blende, like that of the Burton colliery, shows great resemblance to the ore from the Asturias in Northern Spain. It is a curious circumstance that all the blende found in Belgian collieries occurs in grits at the floor of coal-seams.

Galena, in the form of tiny crystals, has been found in the massive grit which occurs below the Stenaye coal-seam, in the Fanny pit of the Marihaye colliery. This grit has been correlated beyond a doubt with a grit-bed containing plumbiferous veins in the Charleroi coal-basin.

Chalcopyrite has been recorded from the Abhooz colliery, where the fractured surfaces of a very hard, vitreous, grey grit, which forms the parting between two coal-seams, are encrusted with that sulphidic ore. In the Bois d'Avroy colliery, minute crystals of iron- and copper-pyrites occur on calcspar which (together with fine bipyramidal quartz-crystals) encrusts the fissures of a calcareous grit lying some 5 feet above the Wicha coal-seam.

Heavy spar is fairly abundant in the Upper Coal-measures of the Mons coal-field; it also occurs, at much lower horizons, in the Havré and Soye collieries. The author thinks that there can be little doubt that all these minerals, occurring as they do in the only Coal-measure rocks capable of retaining open fissures (namely grits), are the results of precipitation in those fissures (by evaporation or otherwise) of the metalliferous and other particles carried in solution by percolating waters. L. L. B.

ERECT TREE-TRUNKS IN THE BELGIAN COAL-MEASURES.

Découverte de Troncs d'Arbres-Debout au Charbonnage d'Oignies-Aiseau. By X. Stainier. *Bulletin de la Société Belge de Géologie, de Paléontologie et d'Hydrologie*, 1903, *vol. xvii, Mémoires, pages* 539-544 *and* 1 *plate.*

The author points out that the discovery of well-preserved tree-trunks in the Belgian Coal-measures is not of very common occurrence, and yet he has had the good fortune to record two discoveries of this nature within a very short time. He recently described fossil trees found in the Falizolle colliery in the Lower Sambre district, and now he deals with that found in the neighbouring colliery of Oignies-Aiseau, in the roof of a seam at the 1,050 feet level. The seam is known as the Great St. Martin, and is 148 feet lower down in the series than the Ahurie or Lambiotte seam, in the roof of which tree-trunks were discovered at the Falizolle colliery. The trunk (20 feet high) is cut by a fault, and is moreover bent and "nipped" at one point. Fine remains of *Calamites* occur in its immediate neighbourhood, but their anatomical connexion with the trunk could not be established. Above this trunk occurs a thinner one; and the discovery of a third tree was announced while the author's paper was being passed through the press, though No. 3 is in all probability but the detached basal part of No. 1, displaced eastward and upward by the fault already mentioned.

Occasion is taken to record the previously-unpublished discovery of a Calamitean trunk in No. 14 pit of the Monceau-Fontaine colliery, but in this case there is no doubt that the tree had been torn from its natal soil and drifted into its present position. L. L. B.

COAL-MEASURES IN FRENCH LORRAINE.

Le Terrain houiller en Lorraine française. By FRANCIS LAUR. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxix.*, *pages* 1048-1049.

A boring put down at Eply, north-east of Pont-à-Mousson, has struck carbonaceous shales of Coal-measure age, at a depth of 2,230 feet below the surface. Moreover, coal-seams have been passed through, and an average sample of the mineral yields the following analysis:—Fixed carbon, 48·77 per cent.; volatile matter, 36·12; ash, 13·23; and hygroscopic water, 1·28. Prof. Zeiller has determined the fossils submitted to him as belonging to the Westphalian stage, or middle sub-stage of the Saarbrücken coal-field. There is every probability of the lower stage of Saarbrücken, with its 117 seams of bituminous coking-coal, being met with below the measures already struck. The boring passed through the Keuper, the Muschelkalk, the Bunter Grits and the Vosges Grits, in regular succession before reaching the Coal-measures, but little or no Permian was found. Another boring, at Lesmesnils, has also struck the Coal-measures.

This new discovery confirms the conclusions published by the author in 1900, as to the extension of the Saarbrücken coal-field into French territory along the axis of Wenkirchen-Pont-à-Mousson; the Hercynian fold here is thus shown to be parallel with the Essen-Dover axis, the Villé-Autun axis, and the Ronchamp-Creusot axis. The author believes that the Coal-measure anticline extends from Pont-à-Mousson to Nancy, over a breadth of 15 to 20 miles; and that we have here, perhaps, the most considerable hidden coal-field yet discovered. He suggests its extension north of Commercy, its passage below the Parisian Cretaceous, and its re-emergence in the West of France, after a course of 375 miles or so. L. L. B.

LIGNITES OF THE AIN, FRANCE.

Sur les Lignites de l'Ain. By EMILE CHANEL. *Bulletin de la Société Géologique de France*, 1903, *series* 4, *vol. iii.*, *pages* 67-73.

The department of the Ain is fairly rich in lignite-deposits, but at present only three of them are being worked. The main object of the author is to show that they were formed by phenomena analogous to those observed nowadays, namely:—(1) Formation of superposed layers by river-drifted plant-débris, which subside to the bottom when their saturation by water is sufficiently complete; and (2) accumulation and burial of plant-débris by torrents towards their "cone of dejection."

The orogenic movements which ridged up the Alps and the Jura had their natural effect on the relief of the Ain region, the configuration of which passed through several phases, conditioning a different "hydrographic *régime*" in each phase: thus, for instance, the rivers, among them the Saône, were at one time all shifted farther westward.

The lignites of Priay, Varambon, Mollon, Ambérieu, Ambronay, and St. Jean-le-Vieux are all regarded by the author as of Pliocene age. They belong to the first of the two categories above-mentioned, and are interbedded with marls. The Douvres deposit, south of Ambronay, belongs, on the other hand, to the second category. It is worked by adits: the lignite-seam, about 8 feet thick, dips into the hill, and the bottom of the deposit has not yet been reached. At Soblay, three thick seams of lignite (each from 6½ to 10 feet) are worked opencast. They are interbedded with thick, highly fossili-

ferous marls. These are probably of Pliocene age. At La Rasa, a lignite-seam, barely 40 inches thick, is associated with pottery-clays and fire-clays. The fire-clay is the main object of mining operations at this locality. It is of a very pure white, after having been washed free of the accompanying sand, etc., and the annual output of 50 metric tons does not suffice to meet the demand. The selling price is about 15 francs per cubic metre (say 4½d. per cubic foot). The deposits here are possibly of Miocene age.

In all the lignite-deposits described in this paper, the greater portion of the material consists of branches and tree-trunks, the ligneous tissue of which is still clearly discernible. The remainder consists of débris of bark, leaves, etc. L. L. B.

ANTIMONY-MINES OF LA LUCETTE, FRANCE.

Sur les Mines de la Lucette (Mayenne). *By* M. Michel. *Bulletin de la Société française de Minéralogie*, 1904, *vol. xxvii., pages* 79-80.

Since 1898 a stibnite-deposit has been worked at La Lucette, near Laval, in the Department of the Mayenne. It occurs in quartz-veins which cut through slates and micaceous grits of Upper Silurian age. The predominant ores are the stibnite and mispickel, with which are associated iron-pyrites, and (more rarely) blende and native gold. The gangue is mainly quartz, but calcite and fragments of slate and grit also occur in the infilling of the veins. These veins have a general north-easterly strike, and an all but vertical pitch; they vary in thickness from about 8 to 32 inches. The mispickel is highly auriferous, and so too is the pyrites. The antimony-ore is in the form of lamellar masses and acicular crystals, some of the latter equalling in size the big stibnite-crystals found in Japan.

From the point of view of their structure and mineralization these deposits of La Lucette may be regarded as analogous to the well-known auriferous stibnite-deposits of Bohemia and Hungary. L. L. B.

KIESELGUHR-WORKINGS IN CENTRAL FRANCE.

Découverte et Exploitation de Gisements de Silice (Diatomées fossiles) dans l'Arrondissement de Murat (Cantal). *By* J. Pagès-Allary. *Compte-rendu de la Trente-deuxième Session (1903) de l'Association française pour l'Avancement des Sciences*, 1904, *part i., pages* 217-218.

Since 1901, the author has discovered and worked four deposits of kieselguhr, all situated within easy reach of the railway-station of Neussargues; and in 1903, in conjunction with another capitalist, he opened up the immense deposit of Faufoulioux, barely 2 miles out of the town of Murat, in the department of the Cantal. The five workings above-mentioned occupy an area of some 30 acres, and the workable beds vary in thickness from 26 to 33 feet, the entire mass probably amounting to about 32 million cubic feet, of an estimated market-value which ranges between £1,000,000 and £1,200,000. To that extent France will in future, it is hoped, be independent of the importation from Germany and Italy.

The deposit consists of the frustules of fossil siliceous algae (Diatomaceæ); some of the stuff extracted is being ground up for polishing-powder, etc., but the author expects to find a great many other industrial uses for it, as it is a refractory material, a bad conductor of heat, and yet very light.

L. L. B.

STANNIFEROUS VEIN IN THE LOZÈRE, FRANCE.

Sur la Présence de l'Étain dans le Département de la Lozère. *By* MARCEL GUÉDRAS. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii., page* 1121.

Although the department of the Lozère is rich in metalliferous veins, tin-ore had not hitherto been recorded there. Recently, however, the author came upon a vein of it, striking south-east and north-west, close to the great Monastier fault, in the parish of Barjac. The country-rock is mica-schist, the vein dips 60 degrees, and is 7½ feet thick at the outcrop. The gangue consists chiefly of barytes and quartz: between these is a thin band of cassiterite, barely an inch thick, with which are closely associated pyrolusite and wolfram. Near by, another deposit of wolfram occurs, which, on analysis, yields 65 per cent. of tungsten trioxide with traces of gold. The stanniferous vein above described is now found to be intersected by another vein containing the same ore. All these occurrences are in the near neighbourhood of an important barytes-mine. L. L. B.

ORE-DEPOSITS OF THE SCHAUINSLAND, BADEN.

Beitrag zur Kenntniss der Erzlagerstätte am Schauinsland. *By* IMMANUEL LANG. *Mittheilungen der grossherzoglich badischen Geologischen Landesanstalt*, 1903, *vol. iv., pages* 485-524, *with* 7 *figures in the text and* 1 *map.*

The chief rocks of the district are gneisses, traversed by granitic and pegmatitic dykes, and a dyke of mica-trap. These are described in some detail by the author. The workable ores are chiefly zinc-blende, and, secondarily, galena. The first-named ore is nearly always brown or black, but a paler mineral, so-called "honey-blende," has been observed (though rarely) in druses in the southern veins. A chemical analysis of the workable blende from Hofsgrund shows it to consist of 79·08 per cent. of zinc sulphide and 20·83 of iron sulphide: but the percentage, both of zinc and of silver, in the ore varies, as a matter of fact, considerably. Thus, six analyses show from 47·32 to 57·96 per cent. of metallic zinc, and from 0·066 to 0·105 per cent. of silver. On the whole, the northern veins, now being worked, are the poorest. Galena constitutes entire veins in the south and south-west of the area, but decreases northward, being found in that direction continuously more and more intergrown with blende, until it disappears entirely. The percentage of metallic lead in the galena is always about 70, but that of silver varies from 0·032 to 0·146. In the Willnau vein, a very small quantity of gold also occurs (1·9 parts in 10,000,000). The gangue-minerals are quartz (of two periods), baryta, calc-spar, dolomite or ankerite (rather abundant), and pyrites—the two last-named being invariable associates of the workable ores. Minerals of a later formation and of less frequent occurrence are pyromorphite, malachite, eusynchite (vanadinates of lead and zinc), anglesite, etc.

The metalliferous veins form two main reefs, striking north-north-eastward and south-south-westward through the area. The thickness in ore of the easternmost of the two main reefs averages 12 to 16 inches of blende, and about 2 inches of galena; that of the westernmost, 4 inches of galena, and only $\frac{3}{5}$ inch of blende: but the veins thicken continuously in depth, while the gangue decreases. So, the deeper they are worked the more productive they are. Nearer the surface, much of the ore has been weathered away by atmospheric agencies, but there is no ferruginous gossan, properly so-called.

The curious brecciated structure of many of the veins is described and figured, and the author then proceeds to deal with the question of the genesis of the ore-deposits. Their analogy in many respects to those of Saxony is pointed out, and their history is sketched as follows. During the formation of the Rhine Valley in the Tertiary Era, fissures were opened up in the neighbouring gneiss-massif of the Black Forest; these did not, however, reach quite to the surface, while below they admitted of the free ingress of metalliferous solutions coming from great depths. Through the sudden release of pressure, these solutions flowed up into the fissures, leached out the mica from the adjacent country-rock, and, on cooling, precipitated the particles of ore on the walls of clefts, and cracks and fissures, and on the rock-fragments which in places choked up the fissures (hence the "brecciated" veins). This encrustation of the gneiss-fragments prevented in the latter case further chemical decomposition of the gneiss. L. L. B.

IRON- AND COPPER-ORES OF THE KNOLLENGRUBE, NEAR LAUTERBERG-AM-HARZ, GERMANY.

Die Knollengrube bei Lauterberg am Harz. *By* K. Ermisch. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 160-172, *with* 4 *figures in the text.*

The Knollengrube (or Knollen mine) takes its name from the neighbouring boss of quartz-porphyry (2,253 feet above sea-level), the Grosse Knollen, which is intrusive among the slate-rocks that form the southern margin of the Harz. The iron-ores, etc., occur as reefs or veins among the so-called Tanner Grauwackés, which, on the strength of the palæobotanical evidence, are assigned to the Culm-measures. Among them occur parallel inliers of the siliceous, honestone-like Wieder Slates, which are probably Devonian. The Lauterberg district was for many generations, from the Middle Ages until about half-way through the nineteenth century, the scene of active mining operations directed to the cupriferous veins now practically worked out. If the strike of one of these veins be prolonged north-westward, it will be found to coincide with the hæmatite-reef of the Knollen mine. But it has been contended, by Prof. Kayser among others, that the barytes-*cum*-iron-ore veins belong to a different fissure-system from that to which we must assign the cupriferous quartz-veins. However that may be, there are two very distinct types of veins formerly worked on the Knollengrube concession: (1) the main hæmatite-reef, averaging 40 inches in thickness, with barytes as the sole gangue-mineral; and (2) the copper-reef, the chief ores of which are copper-pyrites and some of its derivatives, with a little iron-pyrites and some hæmatite. The gangue is mainly quartz, barytes playing quite a subsidiary part. The second reef strikes at an acute angle with the first, and at one point attains the enormous thickness of 98 feet. It has been suggested more than once that the hæmatite-reef is in reality merely the capel of a deeper-lying cupriferous deposit, but the author sets himself to point out that this hypothesis is untenable. Crush-conglomerates consisting of striated grauwacké-pebbles, ranging in size from a pea to a man's fist (or even bigger), occur within the hæmatite-deposit itself, and bear witness to the tremendous frictional effects of earth-movements. Indeed, a detailed study of the series of samples of ore obtained from the mine reveals the widespread cataclastic character of the infilling. Evidence of faulting, folding and overthrust among the neighbouring rocks is abundant. It may be observed that the

extreme limits of the metalliferous district are marked by conspicuous bosses of quartz-porphyry, and sills, sheets, dykes, etc., of similar eruptives occur within the district. Whence one is led to infer some genetic association between the porphyry-eruptions and the formation of the fissures now infilled with metalliferous deposits. Dr. Klockmann has suggested that these fissures were filled with material leached out from the overlying Permian rocks, but the author does not appear to agree with this view, which he regards as somewhat far-fetched.

He gives a description and sections of the workings of the Knollengrube, the latest deep level in which was driven in July, 1903, some 600 feet below the crest of the ridge which divides the Knollen valley from the Hübichen valley. The mining concession, worked up till 1870 by the Government, is now, after sundry vicissitudes, worked by the Hanover-Brunswickian Mining Company. The iron-ore is one of the best that is got in Germany, similar in quality to Cumberland hæmatite, and contains (crude ore) from 60 to 70 per cent. of iron oxides, while it is remarkably free from impurities such as sulphur, phosphorus, etc. A modern plant (put down in 1902) is used for sorting the ore, the picked hæmatite containing from 73 to 80 per cent. of iron oxides: a bye-product, in the shape of fine red ferruginous mud, is sold for dyeing purposes. After a long period of comparative stagnation, a slow upward tendency is perceptible in the industry of this mine: since August, 1903, it has been found necessary to increase month by month the number of workpeople, coincidently with an increasing output. Much unworked ore is in sight, and operations, however actively conducted, are hardly likely to exhaust it for many years to come. One gathers that the copper-ores are no longer worked, or likely to be worked. L. L. B.

WASHINGS FOR GOLD ALONG THE RHINE.

Die Gold-Wäscherei am Rhein. *By* Dr. Bernhard Neumann. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate*, 1903, *vol. li., pages* 377-420.

In compiling this paper, the author has made extensive use of the official records available in the Hessian, Baden and Bavarian Ministries of Finance. With the aid of the information thus obtained he sketches first of all the history of the gold-washing industry along the Rhine, from the times of the Romans down to our own day. The industry appears to have died of inanition somewhere about 1866, but the very last washing for gold recorded on the Rhine took place in the Speyer district in 1900, and yielded something like ½ ounce of the precious metal. The second chapter deals with the question of rights of ownership, royalties, etc.; and the third with the methods of obtaining the gold, as they varied from age to age. As recently as 1846, the illustrious Prof. Daubrée devoted a memoir in the *Annales des Mines* to the distribution of gold in the Rhenish plain "and the manner of extracting it."

The gold in the Rhine gravels and sands is derived from the detritus of quartzose rocks, most of which are of Alpine origin, though some, of course, have been brought down from the Black Forest on one side and the Vosges on the other. The richest gold-finds were made in quiet waters near low banks, or on the margin of islets, especially after a spate; and the best stretch of the river for the purpose was from Kehl to Daxlanden, no auri-

ferous beds being found below Mayence, and very little gold upstream between Waldshut and Basel. Annual statistics of the production are supplied, extending, in the case of the Grand Duchy of Baden, from 1748 to 1874, and in that of the other States concerned, over shorter periods.

The author sees no prospect of reviving the industry, which at one time furnished a livelihood to several hundred persons. L. L. B.

ORIGIN OF THE KUPFERSCHIEFER ORE-DEPOSITS, GERMANY.

Formen, Alter und Ursprung des Kupferschiefererzes, zur Beurtheilung der Mineralbildungen in Salzformationen. By FERD. HORNUNG. *Zeitschrift der Deutschen geologischen Gesellschaft*, 1904, *vol. lvi., pages* 207-217.

In controverting the theory that the metalliferous contents of the Kupferschiefer represent the results of an impregnation of the shales by mineral springs subsequent to the deposition of the former, the author first of all points out that the ores vary to such an extent in character as well as in abundance, that the hypothesis would require a great number of thermal springs of extremely-diverse composition, welling up from rocks of different age and of every description, with a very restricted period of activity.

The author holds that the highly-concentrated mother-liquors resulting from the evaporation of sea-water, at an epoch when most of the Rothliegende beds had been laid down (but when the Zechstein or Permian sedimentaries had not yet been deposited) induced deep-seated alteration in all the rocks to which they could gain access. The most striking characteristics of this metamorphic process are the widespread, nay, universal, evidence of oxidation and the frequently-observed precipitation of red iron-oxide. The effect of the oxidizing action was that the saline mother-liquors gradually took up all sorts of heavy metals from the diabases, from the crystalline schists, and from such metalliferous veins as may then have been in existence. Thereafter the ocean suddenly broke into the lagoons and swamps below sea-level where these mother-liquors were stagnating, heaping up in places the gravels and sands which constitute the Zechstein-conglomerate. Meanwhile, owing in part to the decomposition of the marine organisms swept in by the flood, and in part to the deposition of the sediments forming the Marl-slates, the metalliferous particles were precipitated, and sorted out or distributed by the currents. The consequence, of course, is that the wealth of ore in the Kupferschiefer diminishes from below upward; since the original "stock" of heavy metals present in the waters of the salt-lagoons diminished *pari passu* with their precipitation, and the stock was not being renewed by the suppositious agency of thermal springs. The relative permeability of the overlying or underlying sediments seems to have been of no account in the process; nor is the metalliferous content of the Kupferschiefer apparently determined by the amount of bitumen which it contains (from 8 to 30 per cent.). The author describes the occurrences of quartz and heavy-spar in association with the ore-deposits of the Harz, and the intimate connection traced between manganiferous sediments and saline mother-liquors, as so much additional evidence in favour of his contention. For the process of alteration to which he traces the genesis of the Kupferschiefer ores, he suggests the term "halurgometamorphism," as with the term "regional metamorphism" geodynamic phenomena are generally associated.

L. L. B.

IRON AND MANGANESE-ORES IN THE GRAND DUCHY OF HESSE.

Eisen und Mangan im Grossherzogthum Hessen und deren wirthschaftliche Bedeutung. *By* C. CHELIUS. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 356-362.

The author first of all devotes a few paragraphs to the (industrially speaking) less important mineral-occurrences in the Grand Duchy, as, for instance, the cupriferous veins of the Odenwald; the plumbiferous slates which crop out in the spurs of the Taunus, at the margin of the Wetterau district; the brown-coal workings, the kieselguhr and bauxite-deposits of the Vogelsberg, etc. (the discovery of further brown-coal-fields is by no means unlikely); the saline deposits and brine-springs of Wimpfen, etc.; the barytes-mines of the Eastern Odenwald, and so forth.

The total output of manganiferous ores from Hesse-Darmstadt amounted for 1903 to some 150,000 tons, and that of iron-ores (pure and simple) to about 70,000 tons. The Odenwald manganese-ores are overlain by the red and mottled Lower Bunter Marls, while they are underlain by Zechstein (Permian) dolomite, Rothliegendes, or granite. These ores are very probably the residuum left from surface-decomposition of the Zechstein dolomite, and are most thickly bedded where they fill up depressions in the extremely-irregular surface of so much of the dolomite as still remains. The ores may be described as blackish, crumbly, manganiferous brown hæmatites, containing from 10 to 22 per cent. of metallic manganese and from 10 to 20 per cent. of iron: the relative percentages varying until the ores pass into a red or yellow material very much richer in iron than in manganese. Nodules, nests, reniform and stalactitic concretions of crystalline pyrolusite and barytiferous psilomelane (containing from 59 to 69 per cent. of manganese protoxide), occur in clefts or cavities, or irregularly strewn about in the mass of the deposits. In olden days the deposits were worked for the sake of the iron, but now they are more actively worked than ever, though for the sake of the manganese. Much hidden treasure, in the shape of unworked ore, lies in the Odenwald awaiting the touch of the miner's pick; but an indispensable preliminary to successful working will be a careful study of the stratigraphical conditions of the deposits, and more especially of the tectonics of that mountainous district. Neglect of such a study has led to waste of time and labour on practically-useless concessions lying in the Bunter-Sandstone area, where the ore, if it be there in workable quantity at all, lies buried beneath 1,000 or 1,500 feet of Trias. However, even if nine-tenths of the iron- and manganese-mining concessions in the Odenwald may be regarded as valueless from the industrial point of view, the remaining tenth constitute a valuable and easily-workable group of deposits. The building of certain new lines of railway is likely to contribute to the recrudescence of the mineral-industry in the district.

Turning then to Upper Hesse, the author refers to the active mining operations in the neighbourhood of Giessen, which have been carried on uninterruptedly for many generations; as also to the recent revival of such activity at Oberrosbach near Friedberg; and he further enumerates other localities where the prospects of successful mining are favourable. Here the manganese-ores are chiefly associated with the Devonian *Stringocephalus*- or *Pentamerus*-limestones, but the origin of part of them at least is, *mutatis mutandis*, lithologically and chemically the same as that of the post-Permian manganese-ores of the Odenwald, and their character and composition are also very similar. There are, however, rich crystalline pyrolusites not so

closely associated with the limestones, which appear to have been deposited from solutions that percolated upward along the marginal fault-fissures of the limestones and the slates. At Giessen, the workings are opencast, while at Oberrosbach they are underground.

In the north-western part of the basaltic area of the Vogelsberg, patches of red soil, in vivid contrast with the usual grey and dark-brown of the loams, etc., resulting from the decomposition of the basalts, reveal the outcrops of iron-ore. Great opencast workings are in fair activity at Bernsfeld, Niederohmen, Flensungen, Ilsdorf and Stockhausen: the brown hæmatite which is mined at these localities occurs in nodular or pisolitic form, or in great banded lenticles, among highly-weathered masses of basalt. The ore-occurrences coincide with areas of great faulting, and it would seem that the overthrust and sheared basalts must have been partly brecciated and fissured, and that the hæmatite is the residuum from ferruginous thermal waters which welled up through the fissures. In some cases these original or primary hæmatites have been washed away and re-deposited in the form of gravels or alluvia, thus constituting secondary deposits. The quality of the Upper Hesse hæmatite makes it a favourite at blast-furnaces where it has once been used, but the comparatively-heavy transport-charges to the Rhine and the Ruhr tell against it in competition with other ores. This is a difficulty which the proposed canalization of the Lahn may obviate, at some future time. Large areas of ore still await working, but the same blunders in regard to concessions have been made by too ardent prospectors as in the Odenwald. The bauxite-deposits of the Vogelsberg lie along the north-and-south and west-and-east iron-ore belts, and the bauxite is now being dug in large quantities at Grünberg and other localities. L. L. B.

GENESIS OF THE DEVONIAN RED HÆMATITES OF NASSAU.

Sind die Rotheisensteinlager des nassauischen Devon primäre oder sekundäre Bildungen? By F. Krecke. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 348-355, *with* 1 *figure in the text.*

Nearly every author who has written on these deposits has explained their origin, in accordance with Prof. Bischoff's theory, as due to metasomatic replacement of limestone by iron-ore. Dr. Krecke holds, however, an entirely-different view, and concludes that the Nassau ores are neither more nor less than the outcome of primary deposition. One of the favourite contentions of the "metasomatists" is that the iron was derived from the neighbouring *schalsteins* and diabases: many facts, however, are adduced to show that this assertion is baseless. Much of the diabase is actually of later age than the iron-ores, and near the junction these have been altered by contact-metamorphism from hæmatite to magnetite. It is also difficult to understand why the beautifully-preserved calcitic shells of the numerous fossils in the so-called "Fluss-stein-beds," etc., should have survived a metasomatic process which is supposed to have dissolved away the impure limestones themselves. Stress is laid on the constancy of the Nassau hæmatites to a particular horizon, at the precise boundary between the Middle and the Upper Devonian, characterized by a Goniatite known as *Prolecanites tridens*. It would be curious indeed if the supposed metasomatic change had been confined to that horizon throughout Nassau, while other limestone-beds had remained unaffected by the percolation of the (hypothetical) ferruginous solu-

tions. It will be noted, too, that where the hæmatites are intercalated among the limestones, the ore-bands are sharply marked off from the underlying and overlying barren rock, there being no trace of a passage from one into the other. Finally, the chemical composition of the Nassau ores, their deficiency in magnesium carbonate and manganese, forbid the acceptance of the metasomatic theory, so far as they are concerned.

The author thinks that during and after the submarine eruption of the Middle Devonian diabases, iron-bearing solutions and vapours had access to the waters of the sea, and, as a result of chemical reactions which he describes, the iron-ores were precipitated from them on the sea-bottom. L. L. B.

THE LORRAINE ANTICLINE AND THE SAARBRÜCKEN COAL-FIELD.

Der lothringische Hauptsattel und seine Bedeutung für die Aufsuchung der Fortsetzung des Saarbrücker Kohlensattels. By L. VAN WERVEKE. *Centralblatt für Mineralogie, Geologie und Paläontologie*, 1904, *pages* 390-395, *with a map in the text.*

The most striking feature in the geological structure of German Lorraine is the protrusion of the Bunter Sandstone south-westward into the Muschelkalk area, from the Saar up to Hargarten and Lubeln, and the corresponding protrusion of the Muschelkalk amid the Keuper rocks up to Vaucremont, near Rémilly.

In the sandstone-area or Kreuzwald plain, the extension of the coal-bearing anticline of Saarbrücken was already proved some 50 years ago by boreholes, and the above-mentioned protrusions are conditioned by the existence of what has been termed the "Buschborn anticline." This anticline has now been traced as far as Gézoncourt, and possibly extends yet farther to the south-west. In preparing a tectonic map of Alsace-Lorraine, the author has had recent opportunities of studying more closely the tectonic details of the country, and he finds that the chief anticline is divisible into two portions, a northern or Buschborn anticline proper, and a southern or Fletringen anticline: the two together constitute what he terms "the main anticline of Lorraine." The two portions are united in the Muschelkalk area by means of the Füllingen syncline, and in the Keuper area by the Rémilly syncline.

More than half a century ago it was pointed out that the westward extension of the Saarbrücken coal-field should be sought for, preferably along the summit of the anticline. Boring-operations to this intent, suspended since 1856, were renewed in 1900, both in French and in German territory. What are considered the most favourable indications in regard to coal have been reported from Baumbiedersdorf and Lubeln, localities which lie on the strike of the southern or Fletringen anticline. The author emphasizes the desirability of searching for coal along that line, and the importance of not confining the investigation to the Buschborn or northern anticline. He remarks that the results of the recent boring-operations are on the whole shrouded in an inpenetrable veil of secrecy, but the news has leaked out that borings put down in the most highly-disturbed area between the two anticlines, at Silbernachen (or Servigny) and Füllingen, have been unsuccessful. L. L. B.

BORING FOR COAL AT THE POTZBERG, RHENISH PALATINATE.

Die Tiefbohrungen am Potzberg in der Rhein-Pfalz. By A. Leppla. *Jahrbuch der königlich Preussischen geologischen Landesanstalt und Bergakademie zu Berlin für das Jahr* 1902, *vol. xxiii., pages* 342-357.

About 1890, a boring was put down in the Spelgenbach valley, at the southern base of the Potzberg, in the hope of striking the Coal-measures of the Saarbrücken group at a workable depth. Boring-operations were carried down to a depth of 1,312 feet from the surface, and coal was reported at several points in the cores, but it is not now definitely known whether the occurrence was of industrial importance. Then a boring was put down in the Wildfrauenloch, in the Lochwiesgraben, and, owing to certain technical difficulties, was abandoned at a depth of 1,050 feet from the surface: traces of coal were found at the depth of 679 feet.

A third boring, some little way farther up the Lochwiesgraben valley, was carried down to a depth of 3,795 feet from the surface. Coal was first found in the cores between the depths of 2,397 and 2,552 feet, in strata of the Lower Ottweiler group, but no opinion can be expressed as to the thickness of the seams, if such they be. The lie and succession of the rocks, their character, and the nature of the coal and plant-remains contained in them, all go to prove that, from the depth of 3,275 feet downward, the boring was going through the measures of the Middle Saarbrücken or Flammkohlen group. Coal was found again and again after the depth just mentioned had been reached, and at 3,539 feet, a core of coal 3¼ feet thick was obtained. This is a sufficient indication that the coal-bearing beds of the Saarbrücken series continue in a north-easterly direction into the Palatinate, and they appear to dip less steeply the lower down from the surface that they occur: the dip shown for them in the boring is from 5 to 10 degrees only. It now rests with mining engineers to determine the best method of making industrial use of the information which this important boring has supplied.

L. L. B.

BORING FOR COAL IN SAXONY.

Wo könnte in Sachsen noch auf Steinkohlen gebohrt werden? By K. Dalmer. *Zeitschrift für praktische Geologie,* 1904, *vol. xii., pages* 121-123.

This third paper apparently completes the survey of the subject which the author had begun in 1902.* With regard to the Döhlen basin, south of Dresden, the coal-bearing strata are shown by their fossil organisms to belong to the Lower Rothliegende, and not to the Coal-measures proper. The area between Nieder-Hermsdorf and Grumbach, forming the westernmost portion of that part of the coal-field which lies to the left of the Weisseritz, has not yet become the site of boring operations, but it appears very unlikely that workable seams will in any case be struck there. The exploration-work carried out at the Government Zaukerode colliery has proved that the main seam of the Döhlen coal-field becomes increasingly impure in the direction of Nieder-Hermsdorf, until it reaches the stage of complete unworkability.

It has been suggested that, in regard to that portion of the Döhlen coal-field which lies to the right of the Weisseritz, the neighbourhood of Quohren would form a good field for boring-operations. The author, however, adduces stratigraphical evidence to show that the prospect of finding workable coal there is very remote indeed.

* *Trans. Inst. M.E.*, 1903, vol. xxiv., pages 695-696.

He then considers the possibility of striking coal in the Elbe valley, close to Dresden itself. There is no doubt that Rothliegende strata do occur there, deep below the Cretaceous and later deposits. Deep borings alone can determine whether the coal-bearing shales of the Lower Rothliegende are also present.

Although the discovery of extensive coal-fields in the Erzgebirge is not to be hoped for, recent exploration-work in the Carboniferous area of Brandau has revealed the presence of a coal-seam, 6½ feet thick, at a locality where the rocks had been mapped as gneiss by the Saxon Geological Survey. The surface there is covered by an immense mass of gneissic débris, which makes it impossible to say exactly where the gneiss ends off and the Rothliegende begins. On the whole, however, expenditure on boring-operations in the region of the Erzebirge is unadvisable. The author concludes with the reiteration of his previously-expressed opinion that the area north of Leipzig and between Riesa and Elsterwerda would probably repay a search for coal, and he indicates the points where trial-borings should be put down.

L. L. B.

ORE-DEPOSITS OF THE SCHWARZENBERG DISTRICT, ERZGEBIRGE.

Über die Erzlager der Umgebung von Schwarzenberg im Erzgebirge. By Dr. R. Beck. *Jahrbuch für das Berg- und Hüttenwesen im Königreiche Sachsen*, 1904, *pages* A56-A96, *with* 6 *figures in the text and* 2 *plates.*

The first portion of this monograph was published in the *Jahrbuch* of the Saxon Department of Mines for 1902, and the second portion now published deals in the first place with the Breitenbrunn series of deposits, mineralogically and historically the most interesting of any in the district; but active working on these deposits is now confined to a single mine, that of St. Christopher. The consequence is that much of the author's descriptive matter in regard to the Breitenbrunn series is drawn from the memoirs of Messrs. Freiesleben, Schalch, and others. The majority of the metalliferous veins traversing the main deposits (magnetite) belong to the silver-cobalt group, while a few (and precisely the most considerable vein of all) belong to the pyrites-blende group; there is evidence also of the existence of veins of cassiterite. The main ore-deposits are intercalated conformably among mica-schists, dipping south-westward, near to the horizon where the schists pass into phyllites. The north-western portion of the Breitenbrunn series comes within the contact-area of the Eibenstock granite, while the south-eastern portion shows no trace of the influence of contact-metamorphism.

The author considers in detail the distribution of the ores in the St. Christopher mine: besides layers or bands of pure magnetite, there are others where the magnetite is much intermixed with sulphidic ores. The last-named are evidently impregnations from the veins which are mentioned above as traversing the main deposit, and it is noticeable that the impregnation is more pronounced and more extensive in the direction of the strike than in any other. The output from the mine, from the beginning of 1901 to June 1904, amounted to 356 tons of arsenical pyrites, 20 tons of zinc-blende, and 10½ tons of magnetite. But the sudden collapse in the output of magnetite imaged by these statistics is traceable to the shutting-down of the Zwickau blast-furnaces; and we are told that the stock of ore at the mine (apart from the above-mentioned output) includes 400 tons of magnetite, 300 tons of zinc-blende, and 10 tons of arsenical pyrites. It is proposed, in the case of the

mixed iron-ore, to separate off the magnetite by the magnetic process, and to make up the "slime" thus obtained into briquettes.

The long-abandoned mine of St. Margaret was re-opened in the spring of 1904, as the demand for radium makes it now worth while to work the deposit for the uraniferous pitch-blende which it contains: its chief output in former times consisted, however, of magnetite, blende and iron-pyrites.

The series of deposits known as the Unverhofft Glück (unexpected good-luck), north-west of Antonsthal, also occur among mica-schists, just outside the zone of contact-metamorphism by which the granite-masses are fringed. The output of ore, at one time considerable, has been of no account since 1887. The predominence of galena and blende and the complete absence of magnetite are to be noted here, although the lithological conditions are otherwise similar to those of the St. Christopher deposit. Cross-veins belonging to the plumbic-spathic carbonate-group are frequent.

The last series of deposits to be described are those situated to the north-west and north of Schwarzenberg itself. They are not very numerous, and the abandoned workings are no longer accessible. Bed-like impregnations of tin-ore, and veins of the same, occur in the zone of intense contact-metamorphism which borders the three granite-masses of Aue, Auerhammer, and Lauter, and the genetic relationship between the ore and the granite-intrusion is undoubted. Pyrites and magnetite-deposits appear to have been worked at Bernsbach and Beierfeld respectively.

Some ore-deposits in other parts of the Erzgebirge are briefly described, in order to show their similarity to those of the Schwarzenberg district, and the author also claims to have observed analogous occurrences in Finland and Central Sweden. His general conclusion is that ore-deposits of the Schwarzenberg type are, in every respect, a consequence of the intrusion of granite (in this instance, among crystalline schists). L. L. B.

RADIUM-BEARING MINERALS OF SCHLAGGENWALD, GERMANY.

Radium in Schlaggenwald. *By* J. Hoffmann. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 123-127.

A description is given of the following minerals from Schlaggenwald in the Saxon Erzgebirge, examined and analysed by the author in the laboratory of the Government Technical College at Elbogen:—Calc-uranite, uraninite (pitchblende), cupriferous uranite, uranium-ochre, gummite, uranotile (?) and "uranium-bloom" (a combination of copper and uranium oxides with phosphoric and silicic acids). Uranium-ochre, uranotile and gummite show much less radio-activity than the other four minerals; and, generally speaking, he finds that it is the crystallized compounds of uranium that show the greatest radio-activity.

Now that mining-operations have been restarted in the Schlaggenwald district, with the view of working the wolfram-, copper- and tin-ores which occur there, it seems likely that the radium-bearing minerals will constitute, as it were, a bye-product of some industrial importance. The tin-ores are associated with the granites, which are of probably later date than the surrounding gneiss of the district. L. L. B.

STANNIFEROUS DEPOSITS IN SAXONY.

Die Erzlagerstätten. By R. Beck. *Erläuterungen zur geologischen Specialkarte des Königreichs Sachsen*, 1903, *Section Fürstenwalde-Graupen, Blatt* 120, *pages* 40-57, *with* 3 *figures in the text.*

The district of Graupen is first dealt with: this has long been recognized as divisible into three mineral areas, that of Steinknochen, that of Mückenberg or Upper Graupen, and that of Knötl. The last-named area is left undescribed for the present, as it really comes altogether into a different sheet of the survey-map.

The best-known vein in the Steinknochen area is the Lucaszechner or Luxer vein, the only one still worked there, at the Martini mine. It strikes due north and south, and generally dips about 35 degrees westward. Most of the other veins of this area have an east-north-easterly strike. In thickness, the Luxer vein ranges between 8 and 12 inches, and often includes small fragments of highly-decomposed country-rock (biotite-gneiss). The vein-stuff is of exceedingly-variable composition, but its main constituent is a milk-white drusy quartz: coarse-grained orthoclase and violet fluorspar are of common occurrence. The principal ore is a brown or yellowish tinstone, developed in fairly-big compressed, columnar crystals. Copper-pyrites and galena are occasional associates, and the decomposition of the former has given rise to malachite and azurite. Later formed druses of barytes are mentioned as a somewhat unusual occurrence in conjunction with tin-ore.

The stockwork of the Preisselberg Hills occurs in immediate association with porphyritic microgranite and granitic porphyry: its most productive portions appear to have been worked out. An abortive attempt was made in 1863 to restart working the ore, but apparently the percentages obtained would only warrant working under exceptionally favourable conditions.

The underground workings of the Mückenberg area are no longer accessible, but mining operations were still in progress there in 1868. The description of these is now of little interest, from the industrial point of view.

Leaving the Graupen district, the author states that on the Zeidelweide, north-east of Fürstenau, a series consisting of at least four parallel veins, of moderate thickness, strike north-eastward through the biotite-gneiss. Two of these have proved eminently workable—indeed the mineral-industry was active in that neighbourhood, from the seventeenth century until the last quarter of the nineteenth. The principal ore is tinstone, but silver-bearing blende, copper-pyrites, and galena also occur. Shortly after 1876 the last mine was shut down. In the district of Tellnitz, veins of pyrites, galena and blende were worked for many generations, but the attempt to revive the mining industry there in 1853 was frustrated by the poor results yielded by the assays made in the Government laboratories at Freiberg. L. L. B.

RECENT DISCOVERIES IN THE COAL-FIELD OF UPPER SILESIA.

(1) *Der Flötzberg bei Zabrze: ein Beitrag zur Stratigraphie und Tektonik des Oberschlesischen Steinkohlenbeckens. By* Friedrich Tornau. *Jahrbuch der königlich Preussischen Geologischen Landesanstalt und Bergakademie zu Berlin für das Jahr* 1902, *vol. xxiii., pages* 368-524, *with* 2 *figures in the text and* 4 *plates.*

Mining operations on the Zabrze anticline have been conducted with such great activity and success, that a time-limit can now be foreseen,

within which the thick coal-seams will be completely worked out. Therefore, the author considers that the moment is opportune for a general summary of all the available knowledge in regard to this Coal-measure anticline. He gives the details of no less than 177 borings and sections measured in shafts, a bibliography consisting of 33 entries, and a full list of the plant-remains and other fossils.

On the south and west, the Zabrze anticline is bounded by faults, while on the north and east the strata gradually flatten out into the basins of Beuthen and Ruda respectively. The Königin-Luise colliery, belonging to the Prussian Government, takes up the lion's share of the Zabrze portion of the coal-field, the remainder of it being worked by five private collieries. The five thick seams (varying from a minimum of 10 to a maximum of 46 feet in thickness) which form the main object of operations here, belong to the Saddle or Anticlinal Group, and form about one-sixth of the total thickness of that group; this group the author places in the stratigraphical succession between the Middle Coal-measures (equivalent to the Karwin Group, *sensu lato*) and the Lower Coal-measures (equivalent to the Ostrau Group, *sensu lato*). The Carboniferous system in the district here described, consisting, apart from the coal-seams, of sandstones, shales and clay-slates, occupies broad tracts at the surface, its outcrop being barely masked by a thin mantle of Drift-loams and sands: the Drift rarely approaches 7 feet in thickness. Immediately above the Anticlinal Group in the stratigraphical succession come the Ruda Beds, including seven or eight coal-seams, the thinnest of which is a 5 feet seam and the thickest a 20 feet seam. The Pochhammer, Reden and Heinitz seams, belonging to the lower division of the Anticlinal Group, yield gas-coal and coking-coal: all the other seams above them are of a different character, being described as non-coking, long-flame coals (*nicht backende Flammkohle*).

The Zabrze anticline is itself traversed by faults and overthrusts, which are, however, of comparative unimportance, and do not greatly affect its general structure. The age of the folding movements which originated the anticline is certainly post-Triassic, and possibly early Tertiary (Miocene).

(2) *News aus dem Oberschlesischen Steinkohlenbecken.* By D. Gaebler. *Zeitschrift für das Berg-, Hütten- und Salinenwesen im Preussischen Staate*, 1903, *vol. li., pages* 497-519 *and* 1 *plate.*

The existence of a northern marginal basin had long been known, but that knowledge was not of a very detailed character, until in 1901 the third of three deep borings was put down near the railway-line north of the village of Mikultschütz, and determined to some extent the course of the main axis of the basin. Still more recent borings have shown a very steep dip of the strata along its southern boundary, and consequently a far greater depth for the basin than had been previously suspected, as well as a northward shifting of its axis. Fifteen workable seams, totalling a thickness of 131·3 feet of coal, were struck between the depths of 546 and 2,710 feet, in boring No. 1 of the Preussen colliery. About the same number of workable seams were passed through in the Villiers shaft and boring, between the depths of 636 and 2,983 feet, with a total thickness of 155 feet of coal. In the last-named boring, brackish-water and marine shells were found at various horizons in the deeper-lying portion of the strata, and sphærosiderite was extraordinarily abundant.

As an example of the great caution needed in correlating, and theorizing on, the results of borings, the author points out the recent case of the

Anna shaft of the Frieden colliery. Here actual sinking operations have proved one seam fewer, but 13½ feet of coal more, than the boring which had been put down in 1900. Nine seams which the boring was thought to have passed through were not found in sinking the shaft, but eight seams missed in boring have been proved in sinking.

The author proceeds to show that his view of the Orlau disturbance, which has been the subject of controversy, has been upheld by the most recent results obtained from borings, and he then describes the favourable outcome of borings lately made on the Jastrzemb anticline. Across the frontier, the five borings put down at Gross-Kaniow, in Austrian Galicia, on the banks of the Vistula, have shown the steepness of dip of the strata to increase continuously with the depth; and it is inferred that south, or south-east, of a line passing through Kurzwald, Bielany, Zator, and Tenczynek, only unproductive Coal-measures or Culm will be found, the latter even being, perchance, replaced by the Carboniferous Limestone, which in the east is known to underlie the Coal-measures.

The deep borings started some 50 feet above the floor of the Leopoldine seam in the Cons. Wanda colliery, at Brzezinka, is regarded as one of the most important borings lately put down in Upper Silesia, as it throws light on the variation in the Schatzlar beds from east to west of the Prussian part of the coal-field, and confirms the correlation of the Leopoldine seam with the Emmanuels-segen and Leopold seams. This boring was carried down to a depth of 3,572 feet, by which time 437 feet of Ostrau beds had been passed through, containing four coal-seams, of which the thickest did not exceed 2⅓ feet. In the overlying measures altogether twenty-six seams were proved, with a total thickness of 124½ feet of coal.

Recent sinkings at Woschczytz, Pallowitz, and Sohrau have shown the gradual rise of the strata to the south, thereby proving that the deepest portion of the great "inner basin" is north of, and near, the first-named locality. From this conclusion it now becomes possible to predicate the depth and lie of the successive groups of Coal-measures, from Chelm in the east to Binkowitz in the west.

Finally the author discusses the results of recent research, as applied to the correlation of the seams in the Jaworzno basin, or "eastern marginal basin," across the Russian frontier, with the seams proved in the German portion of the coal-field.

(3) *Über eine Erweiterung des Gebietes der produktiven Steinkohlenformation bei Landeshut in Schlesien.* *By* J. Herbing. *Centralblatt für Mineralogie, Geologie und Paläontologie*, 1904, *pages* 403-405.

Thanks to the rediscovery of long lost boring-cores from Reichhennersdorf, and thanks also to several new finds of Coal-measure plants, it has been ascertained that the Upper Carboniferous rocks extend at least 2 miles farther to the north-west of Landeshut than all hitherto-published maps allow. Coal may then be looked for in localities where there had been, up till now but little hope of finding it.

(4) *Das Oberschlesische Steinkohlenbecken und seine kartographische Darstellung.* *By* R. Michael. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 11-20, *with* 2 *figures in the text.*

The map of the seams of the Upper Silesian coal-basin on the scale of 1:10,000 is being issued by the Royal Bureau of Mines at Breslau, and the author takes occasion to give a detailed history of what has been done in regard to the geological mapping and description of that area since

1860. The extension of the coal-field into Russian territory has already been mapped on the new scale by the Russian Department of Mines, and identical symbols have been used, so as to coincide completely, and join up, with the German map now being issued. Similarly, the Austrians have published a map of the Ostrau seams, on the scale of 1:10,000.

In 43 sheets the map will cover an area of about 760 square miles, leaving Tarnowitz outside it on the north, Nicolai on the south, and Gleiwitz on the west. This is indeed, only a small portion of the entire Upper Silesian coal-field, which covers (so far as it is known) 5,600 square miles, whereof 4,000 belong to Prussia, 1,000 to Austria, and 600 to Russia. The coal-field is divisible into a central basin, separated by a zone of disturbance from a western basin, and by an anticline from a smaller northern basin. On the east, the coal-field is cut off by the Carboniferous Limestone and the Devonian strata, on the west and north-west by the Culm, but its southern boundary is more uncertain. A list is given of the seventeen localities where the coal crops out at the surface. The productive Coal-measures of this coal-field are divisible into three groups, whereof the middle one is characterized by the number, thickness, and excellence of its seams. These are all carefully distinguished on the new map by different tints and symbols, and six north-to-south sections accompany the map, which the officials arranged to complete in time for the St. Louis Exhibition.

Great efforts have been made of late, in the direction of economical working of the best seams; and many mines now use sand for packing. Meanwhile, more attention is being directed than formerly to the upper group of seams (which constitute a vast amount of available coal), and the centre of gravity of the coal-mining industry seems likely to shift gradually southward. Concessions have been registered and marked out over an extensive area that is still unworked. This will in time involve the preparation of another map, covering the region to the south of the present one. L. L. B.

MAGNETITE-DEPOSITS OF SCHMIEDEBERG, GERMANY.

Die Magneteisenerzlager von Schmiedeberg im Riesengebirge. By Georg Berg. *Jahrbuch der königlich Preussischen geologischen Landesanstalt und Bergakademie zu Berlin für das Jahr* 1902, *vol. xxiii., pages* 201-267, *with* 10 *figures in the text and* 1 *plate.*

The little town of Schmiedeberg lies at the foot of the mountain-range of the Riesengebirge, in the province of Prussian Silesia. Mines were worked here in the Middle Ages, and Schmiedeberg iron enjoyed a widespread reputation in Germany. Various attempts were made in the first half of the nineteenth century to revive the industry, which had come to grief in the Thirty Years' War (1618-1648); but it was not until 1854 that it was found possible to resume really systematic, profitable working of the deposits.

Geologically, the Riesengebirge consists of a central granite-massif generally mantled over by gneisses and mica-schists. Nearly vertical where they abut on the granite, the bedding-planes of these become less and less highly inclined as one recedes from the granite. The crystalline rocks are conformably overlain by the older stratified formations, but are unconformably overlapped by the newer stratified formations, which are all but horizontal. The geographical centre of the range does not precisely coincide with its geological structure: for instance, its highest summit, the Schneekoppe, is at the junction of the granite with the schists.

The author describes in some detail the geological structure of the country round Schmiedeberg, having carefully mapped in 1901 an area of some 8 square miles. This is largely covered with forest: the northern portion is occupied by the porphyritic (newer) granite, and the central and southern portions by the gneisses and schists. Several chapters are devoted to the petrography of these rocks, and in the ninth chapter we learn that silicate-bearing crystalline limestone and hornblende-rock (or amphibolite) are characteristic associates of the ore-deposits, as also certain mica-schists. Quartzites are occasionally intercalated among these.

The magnetites vary in structure from fine-grained to coarse-grained, from compact to crystalline, but really well-formed crystals are not found. The best grade of ore contains about 79½ per cent. of iron peroxide (Fe_3O_4), 3·2 per cent. of silica, 6 of alumina, 7 of iron bisulphide, and 4 of calcium carbonate. Chlorite and biotite are intimately intermixed with the granules of magnetite, and sometimes the flakes of the former two minerals are so numerous as to crowd out the last-named mineral. In some few cases, the microscope has shown limestone passing into magnetite.

Just as there are magnetites in these deposits with which flakes of biotite and chlorite are closely intermingled, so too the author found biotite-schists and chlorite-schists, and also serpentinous decomposition-products, impregnated with magnetite.

The ore-beds alternately thicken and thin out in the most irregular fashion—the mean workable thickness averaging 6½ to 10 feet, though a maximum of 33 feet is sometimes attained. Both at the hanging-wall and at the foot-wall the ore-body is generally sharply marked off from the country-rock—this consists (as a rule) of calc-schists and biotite-schists or hornblende-schists. In the Bergfreiheit mine, ten ore-beds are distinguished, the farewell rock or basement being a limestone some 35 feet thick. Complications in the shape of folding, faulting, etc., are by no means wanting. At present, it is only the mine which has just been named that is being worked on a large scale: the sump is 1,295 feet below the surface.

Sulphidic ores not only occur as an impurity among the magnetites, but are widely spread among the limestones, hornblende-rocks, and other near neighbours of the ore-formation. They are predominantly iron-pyrites and magnetic pyrites, mispickel and copper-pyrites playing only a very subordinate part. These sulphidic ores occur in veins and "nests," and are in all probability the latest-formed minerals of the whole group. With them calcite is intimately associated. One does not gather that they would repay working, although an attempt has been made to work one exposure of them.

Another characteristic feature of the Schmiedeberg deposits is the occurrence of parallel pegmatitic dykes (termed *riegel* or "bolts" by the miners), some of which are more than 6 feet thick. These are probably connected with an after-phase of the granite-eruption, and are of undoubtedly later date than the magnetites.

With regard to the genesis of the ores, the author considers five different hypotheses. A very probable one connected them with the regional metamorphism of the Archæan strata into crystalline schists; and thus it is that they have been regarded by many investigators as analogous to the Scandinavian iron-ores. The author, however, adduces the evidence derived both from macroscopic and microscopic study of the rocks, to show that the Schmiedeberg ores are the result of contact-metamorphism set going by the eruption of the granite. L. L. B.

GENESIS OF THE ORE-DEPOSITS OF UPPER SILESIA.

Die Bildung der Oberschlesischen Erzlagerstätten. *By* A. Sachs. *Centralblatt für Mineralogie, Geologie und Palæontologie*, 1904, *pages* 40-49.

The author exposes in some detail the evidence upon which he bases the following conclusions:—(1) The ore-deposits of Upper Silesia in their present form are epigenetic. "Epigenesis" being understood to mean a later introduction of ores into the already existing country-rock. (2) The ores were introduced from above by concentration of the metalliferous material which was primarily in a very finely-divided state. (3) Dolomitization of the country-rock took place simultaneously with the introduction or percolation of the iron-, zinc- and lead-bearing solutions. (4) With regard to the enrichment of the ores in fissures, the Bernhardi reduction-theory may afford an explanation. This postulates the reduction of sulphates to sulphides by the gases given off from coal-deposits, an hypothesis which illustrates the close association existing between the coal-seams and the ore-deposits of Upper Silesia. It may be remarked that these ores are mainly sulphides (pyrites, blende, galena), but calamine, cerrusite, and a magnificent deposit of brown hæmatite also occur.

L. L. B.

JORDANITE IN UPPER SILESIAN ORE-DEPOSITS.

Über ein Vorkommen von Jordanit in den oberschlesischen Erzlagerstätten. *By* A. Sachs. *Centralblatt für Mineralogie, Geologie und Palæontologie*, 1904, *pages* 723-725.

This sulpharsenide of lead, in this instance containing a small percentage of iron-impurity, was found in a metalliferous mine near Beuthen: it shows the characteristic cleavage of jordanite, besides agreeing with it in chemical composition. The mineral is rare, only two other localities for it being known in the whole world; but its discovery at Beuthen is of some importance in regard to the much-discussed problem of the formation of the ore-deposits of Upper Silesia. It was found in a fissure, about 2 inches broad, lined with galena and zinc-blende and infilled with crumbly galena as well as with the jordanite. These conditions appear to bear out the author's contention that the above-mentioned ore-deposits are of epigenetic origin: that is, that the metalliferous particles, distributed in a state of fine division throughout a complex of rocks, were concentrated and deposited by downward-flowing waters percolating into fissures and cavities. Now, the arsenic which is a constituent of jordanite cannot be traced to the neighbouring masses of ore, and therefore the infilling of the fissures must be regarded as a primary, not a secondary phenomenon; that is, the accumulation of the great ore-bodies of Upper Silesia is due to infiltration into fissures occurring conjointly with metasomatic processes.

L. L. B.

ORE-DEPOSITS OF THE SORMITZ VALLEY, GERMANY.

Kontakterzlagerstätten im Sormitzthale im Thüringerwalde. *By* Hans Hess von Wichdorff. *Jahrbuch der königlich Preussischen geologischen Landesanstalt und Bergakademie zu Berlin*, 1903, *vol. xxiv., pages* 165-183, *with* 7 *figures in the text.*

Of late years, the long-abandoned mineral-industry of the Sormitz valley, in the Thuringian Forest, has been revived, and the re-opening of the ancient

workings has facilitated close investigation of the contact ore-deposits. The three most important of these are:—(1) The magnetic pyrites of the Unterhütte and of the western flank of the Goldkuppe at Leutenberg; (2) the galena and zinc-blende deposit of Weitisberga; and (3) the arsenical pyrites of the Grosse Silberberg at Gahma. The last-named ore-body has not been worked for many years. Active prospecting has revealed the presence of untouched ore-deposits in the immediate neighbourhood, at the eastern base of the Hainberg. All, without exception, lie within the contact-area of the eruptive mass of granite which has invaded the Palæozoic slates, and none are found outside that area.

The old records show that the galena-and-blende deposit of Weitisberga is of very even character, the ores being as rich in depth as at the surface. The new winnings had not reached the actual ore-body at the time of writing, and the author's description is chiefly based on specimens collected from the old waste-heaps. The galena appears to occur in thin bands interbedded among green *hornfelsen* (or cherty rocks), which themselves alternate with metamorphosed limestones. The occurrence of epidote, garnet, and other metamorphic minerals is characteristic. The ores are said to contain a fair percentage of silver, and they impregnate the whole of the Upper Devonian limestones in the contact-area; but the impregnation, as compared with the bedded deposit, is of small industrial importance.

The magnetic pyrites of the Goldkuppe too, occurs among contact-metamorphosed Upper Devonian limestones; where the limestones are unaltered, no trace of the ore is to be seen. According to the original form of the limestone-deposits, so does the magnetic pyrites occur variously in bands or layers, in nodular concretions, in more or less spheroidal grains, or, finally, as a mere infilling of fissures. Beds rich in the ore show at the outcrop a rusty-brown to bluish-black coloration, with a greasy lustre. In conclusion, the author claims that the petrographical evidence brought forward by him, shows beyond doubt that the ores of the Sormitz valley owe their existence to the phenomena of contact-metamorphism. L. L. B.

DEEP BORINGS IN THE MÜNSTER BASIN, WESTPHALIA.

Das Ergebniss einiger Tiefbohrungen im Becken von Münster. *By* G. Müller. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 7-9.

The author describes a series of borings for coal which have been put down within the last decade in the district named. It is true that these borings have failed to reach the coal, but the results yielded by them are of importance, if only for the information which they afford as to the stratigraphy of the Münster basin.

In the Kreuzkamp boring, 2½ miles north of Lippstadt (begun on February 3rd, 1900, and stopped on February 26th, 1901, at a depth of 2,975 feet below the surface, when the Middle Devonian had been reached), the great mass of strata passed through belonged to the various horizons of the Cretaceous, and the Greensand was found directly overlying the Devonian.

As to the Metelen boring, put down in 1899, west of Burgsteinfurt, the cores down to a depth of 2,950 feet are still Upper Cretaceous; and therefore, if Coal-measures do occur in that locality, they would only be reached at a depth of 4,000 feet or so.

The Vreden boring, commenced in 1900, was stopped in 1901 at a depth

of 4,038 feet in the Lower Zechstein (Permian), when probably it was just on the point of reaching the Coal-measures. At this locality, below the Drift and Tertiary Beds, come the Wealden and Lias (that is, all the Cretaceous and most of the Jurassic strata are absent) followed in descending order by Muschelkalk, Bunter Sandstones and Permian. The report that Wealden coal had been struck in this boring appears to be unfounded, but a pre-Glacial peat-bed was proved at a depth of 82 feet or thereabouts.

L. L. B.

THE OCCURRENCE OF PETROLEUM IN WESTPHALIA.

Das Vorkommen von Petroleum in Westfalen. By G. Müller. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 9-11.

An explosion of natural gas on June 28th, 1902, in the course of boring-operations carried out by the Rheinpreussen Company at Haus Sandfort, near Olfen, accompanied by a rush of water with a petroleum-like film on it, attracted great attention in mining circles, as it suggested the possibility of striking oil in the Westphalian coal-field.

At the locality above-mentioned, the highly-fissured *Brongniarti*-beds of the Cretaceous (Pläner) are reached at a depth of 2,100 feet from the surface, and below these come the Coal-measures, with a dip of about 22 degrees. At Walstedde, an explosion of natural gas occurred in the Mansfeld VIII. bore-hole, in the Cretaceous (Pläner), when a depth of 623 feet was attained. The Anneliese V. boring, put down at the cross-roads from Ahlen to Drensteinfurt and Sendenhorst, passed through 16½ feet of perfectly black Greensand, overlying 20 feet of Coal-measure sandstone. The latter dips 75 degrees, is fissured, and permeated with a yellowish-green, greasy substance, possessing a pungent odour of petroleum. It is to the occurrence of petroleum that the author attributes the blackening of the Greensand in this case, as he attributes its reddening in the Mansfeld VIII. and Ascheberg I. bore-holes.

Lately, a boring put down for salt, in Northern Westphalia, struck heavy oil in the porous anhydrite overlying the rock-salt, as well as in the cavernous dolomite below the salt.

The occurrence of bitumen in the upper beds of the Westphalian Cretaceous has long been recorded, but in order to get at the petroleum (of the presence of which the bitumen may or may not be an indicator) it would be necessary to carry borings down into the fissured Turonian strata, that is, down to considerable depths in the area under consideration.

The author does not commit himself to recommending boring-operations of so speculative a character as these would appear to be. L. L. B.

BRINE-SPRINGS FLOWING INTO A WESTPHALIAN COLLIERY.

Kohlensäure führende Solquellen im Schachte Robert der Zeche De Wendel bei Hamm i. W. By — Pommer. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate*, 1903, *vol. li., Abhandlungen, pages* 375-377.

In the south-western district of the De Wendel colliery, near Hamm, are two shafts, one of which has been carried down for more than 650 feet into the Coal-measures, while the Robert shaft has not yet reached those measures. In the latter shaft, in February, 1903, at a depth of 1,495 feet from the surface, a brine-spring was struck which flowed into the sump at the rate of 88

gallons a minute. The salt-water is charged with carbon dioxide, and issues from a calcitic fissure in the white marl. Arrangements were made to draw off the water, in such a manner that 6 hours out of the 24 remained free for the haulage-work involved in continuing downward the masonry-lining of the shaft. But in July, 1903, 223 feet deeper down, a second fissure was struck, and salt-water flowed in from this at the rate of about 18 gallons a minute. Finally, on September 15th, 1903, at a depth of 1,780 feet (65½ feet short of the Coal-measures), a third spring was tapped, from which water welled forth at the rate of 44 gallons a minute, bringing up the total inflow of saline waters into the Robert shaft to 150 gallons a minute, all from fissures in the white marl. These waters are highly charged with salt and carbon dioxide, and appear to flow in under considerable pressure. Further sinking has been suspended, while the two winding-engines available are fully occupied in draining the shaft. The accumulation of carbon dioxide evolved by the water proved fatal to one of the workmen in the shaft, and nearly so to several others. The evolution of dangerous gas diminished greatly after August 14th, 1903. L. L. B.

THE COPPER-ORES OF BOCCHEGGIANO, ITALY.

Note mineralogiche sul Giacimento cuprifero di Boccheggiano. By E. Tacconi. *Atti della Reale Accademia dei Lincei*, 1904, *series* 5, *Rendiconti*, *vol. xiii.*, *pages* 337-341.

A full description of the mode of occurrence and formation of these cupriferous veins was published by Prof. Lotti in the memoirs of the Italian Geological Survey in 1893, the only important correction which now has to be made being in regard to the strike of the principal vein. This is due north-and-south, from the Farmulla valley to that of the Merse, and thence south-east and north-west. The dip is 45 to 50 degrees eastward, the mean thickness varies from 13 to 16 feet, and the most richly-mineralized portions are near the hanging-wall.

The most important ore in the deposit is chalcopyrite, which generally occurs in the form of finely-granular compact masses, more rarely as crystals within geodes. Its most frequent associate is iron-pyrites: this is also found alone in great masses, or in isolated cubic crystals, in the neighbouring Eocene limestone. Other associates are galena, blende and arsenical marcasite; in conjunction with the second-named mineral and chalcopyrite, blackish-grey lustrous venules of tetrahedrite course through the limestone. Of the last-named ore a chemical analysis was made, with the result that it was shown to contain about 31 per cent. of copper, 28 per cent. of antimony, 7 per cent. of zinc, and 6·62 per cent. of silver. Its correct chemical formula, according to the author, would be

$$3\ (CuAg)_2S.\ Sb_2S_3 + \tfrac{1}{4}\ (6\ ZnFeS.\ Sb_2S_3).$$

The high percentage of silver differentiates this variety of tetrahedrite from any other known to occur in Tuscany. In the percentage of zinc it resembles the mercury-bearing tetrahedrite of Val di Castello, but it contains no mercury: while the tetrahedrites of Valle del Frigido contain from 12 to 13 per cent. of iron, but practically no zinc or silver.

The gangue of the principal vein consists of brecciated limestone (occasionally crystalline), quartz, baryta and fluorspar. Tiny prisms of the sulphidic ore, bismuthine, believed to be a so far unrecorded occurrence in Italy, have been found disseminated in a hæmatitic mass, in association with the chalcopyrite and pyrites. L. L. B.

LIMONITE-DEPOSITS IN CAMPIGLIA MARITTIMA, ITALY.

I Giacimenti limonitici di Monte Valerio, di Monte Spinosa e di Monte Rombolo (Campiglia Marittima). By G. Ristori. *Atti della Società Toscana di Scienze Naturali*, 1904, *Memorie*, *vol. xx.*, *pages* 60-75.

With regard to the ore-deposits of Monte Valerio more especially, the author begins by remarking that the disappointing results, which have so frequently attended the exploration-work carried out there, are more justly attributable to the irrational fashion in which such work has been for the most part conducted, than to the comparatively-limited extent of the deposits, both of tin- and iron-ores.

The excavations made on the southern and south-western slopes of Monte Valerio, whether in ancient or in recent times, have been chiefly directed to the search for cassiterite; but veins and venules of limonite have been found to occur in almost constant asssociation with that mineral, a circumstance which suggests a common origin for the two ores. However, ochre is there more abundant than limonite proper; and, moreover, the metalliferous veins thin away to nothing on reaching the deeper-lying strata of the Liassic limestone in which they occur. On the south-eastern slope of the same hill, limonite is seen to form with calcspar the infilling of fissures in an anticlinal fold of the limestone; cassiterite has also been found in the fissures, but it would seem as if the abundance of limonite were detrimental to that of the tin-ore. Analysis shows this limonite to be fairly pure, but it varies greatly in composition and in structure, and in the amount of calcite which in places forms a network of venules within it. The author does not appear to think that deep-level workings would ever pay with these deposits, but outcrops and shallow workings should furnish a reasonable amount of ore, the less to be despised that the industrial revival in Italy is daily becoming more marked. On the eastern slope of Monte Valerio the excavations for limonite have been attended with still less success than elsewhere: the veins are smaller and scarcer, and such ore as has been got is too drusy, and too full of calcitic and even siliceous impurities, to be of much value.

Eastward of these, occupying the slope towards the Pozzatello valley, are outcrops of a limonite which appears to be of excellent quality: it is covered with a sort of black varnish, due, presumably, to the reduction of a dioxide of manganese that forms a constituent of the ore. Exploration-work has revealed payable quantities of ore, and there are other outcrops which have not yet been investigated. The author has greater hopes of the Pozzatello deposits than of any others seen by him in the district. In the valley of Santa Caterina, north of the Pozzatello valley, there occurs among the highly-fractured and contorted limestones a vein which is infilled with a mixture of ilvaite, limonite, and magnetite. The specific gravity and the compact structure of the samples of ore give favourable indications; and, if these should be confirmed by chemical analysis, the mineral would probably rival the best Elban hæmatite. The course of the vein is so irregular, that although the excavations so far carried out have not shown it to be very extensive, it may well be struck again in the neighbouring fissured masses of limestone.

In Monte Spinosa the waxy Liassic limestone is no longer seen: pinkish-white limestones, of gradually-increasing crystallinity until they pass into absolutely-saccharoidal limestones, take its place, the entire hill forming an anticlinal dome. The rocks are fissured in every direction, and with the

fissures are associated numerous outcrops of limonite. Given modern methods of working, and a carefully-planned scheme of operations, the deposits would certainly prove to be of industrial value. It has been shown that the fissuring of the rocks can be traced to the volcanic eruptions which took place in the Eocene period, and with some phase of this vulcanicity the mineralization of the fissures is undoubtedly connected. This occurred over a vast area, including the neighbouring province of Massa Marittima, where so many mines are, or have been, worked.

The author then describes a vein of manganiferous iron-ore near the junction between white crystalline limestones and the lowermost Liassic marls (which overlie them unconformably) at Acqua Viva, near the Botro dei Marmi: it may be worth working for manganese. So too, the old mines of Campo alle Buche might prove to be worth re-opening, as their situation is favourable from the point of view of facility of transport, etc., and the limonite-deposits have by no means been exhausted by the ancient workings.

The most celebrated deposits, however, of the district studied by the author are those of Monte Rombolo. Here, as elsewhere, the metalliferous fissures are broadest near the outcrop and thin away in depth: the fact that occasionally they bulge out into pockets, or branch out into several veins, does not detract much from the general truth of the former statement. Nevertheless, the Monte Rombolo deposits are industrially important, and they are, on the whole, characterized by greater constancy or continuity than the others. The principal fissure strikes first from south-west to north-east, then sweeps round south-eastward in a curve, the convexity of which is mainly directed southward. Secondary veins, of small importance, branch off from it in various directions. The want of success which has frequently attended the spasmodic efforts made to work these limonites appears to be due here, as at Monte Valerio, in great part to the want of forethought with which such endeavours have been conducted, coupled with a disregard of the actual geological conditions of the deposits. L. L. B.

ORIGIN OF THE MAGNESITE-DEPOSITS OF THE ISLAND OF ELBA.

La Formazione della Magnesite all'Isola d'Elba. *By* Giovanni d'Achiardi. *Atti della Società Toscana di Scienze Naturali*, 1904, *Memorie, vol. xx., pages* 86-134 *and* 3 *plates.*

Dispersed on the flanks of the Monte Capanna are great whitish cones which attract the traveller's attention, as he proceeds along the road from Marina di Campo to the hamlet of San Piero: these cones are, in fact, the tip-heaps of the magnesite-workings, the mineral being excavated from a friable, earthy, yellowish-green rock in which it forms an intricate network of interlacing white veins. The author's investigations were limited to a single mine, that of the Grotta d'Oggi; but he purposes to extend successively his researches to the others, more especially if they show any essential differences (from the mineralogical and geological point of view) from the mine just named.

A detailed petrographical description is given of the granitic rocks, the cornubianites, the peridotites, the serpentines, the hornblendites, and the pyroxenites, with numerous chemical analyses, as also of the magnesite itself. The typical mineral contains from 40 to 42 per cent. of magnesia,

and the author considers that there is no room for doubt that it has originated from the alteration of the serpentinous rocks. These, in their turn, were derived from an anthophyllitic peridotite, but the alteration of serpentine into magnesite is, in all probability, of a much more recent date than the decomposition of peridotite into serpentine. It will be noted that the magnesite is apparently associated with the granitic contact-zone; but we are not dealing here with a case of direct contact-metamorphism: it seems probable that the contact-zone, forming necessarily a line of weakness, simply afforded an easier passage than other portions of the igneous complex to the decomposing agencies which transformed the serpentine into magnesite. These agencies were primarily thermal waters of high alcalinity, and in a very secondary degree pluvial waters: the part played by the latter consisting mainly in the partial dissolution and redeposition of magnesite-deposits already formed. L. L. B.

ANTHRACITE-DEPOSITS OF THE WESTERN ALPS, ITALY.

Studio geologico-minerario sui Giacimenti di Antracite delle Alpi Occidentali Italiane. Official. *Memorie descrittive della Carta geologica d'Italia*, 1903, *vol. xii., pages xvi. and* 232, *with* 31 *figures in the text and* 14 *plates.*

This exhaustive work comprizes, in addition to an introductory synopsis, no less than seven descriptive memoirs by as many different authors, dealing with the general geology and stratigraphy of the deposits, with the methods of working and chemical analyses of the anthracites, and with the fossil flora found in association with them. It is preceded by a bibliography consisting of 60 separate entries and covering the literature of the subject from the year 1784 to 1903.

The attention of the Italian Government had been repeatedly drawn to the deposits, before the detailed investigations of which the volume under review is the outcome had been undertaken. But the reports furnished to them by the engineers of the Royal Corps of Mines concurred in representing the anthracites as of small industrial importance, both from the point of view of quantity and quality, and the most recent research now confirms this disappointing conclusion.

The fact that the carbonaceous material is widely diffused through the rocks, the considerable number of outcrops of anthracitic lenticles in different areas (especially in the Valle d'Aosta), the optimistic views of some geologists, and the more or less interested asseverations of certain prospectors, spread abroad the impression that vast unexplored treasures of coal lay somewhere hidden in these Alpine regions: an impression deepened by the rise in price of coal on the Italian market a year or two ago. There were also rumours of a possibility of the revival of the metallurgical industry in the Valle d'Aosta, and so the Government felt impelled to order an investigation that should be sufficiently exhaustive to rank as final.

Generally speaking, these North Italian anthracites all belong to the Permo-Carboniferous formation, which can be traced from the Mediterranean coast at Savona westward into the Ligurian Alps, and thence past Cuneo towards Monte Viso. Across the frontier, the Carboniferous belt is shown to stretch from Briançon north-eastward as far as Sion in the Rhône valley. The anthracite-deposits (in Italian territory) are generally in the form of thin, small lenticles, frequently nipping-out and then thickening again,

extremely irregular in every way, owing doubtless to the intense plication and highly-disturbed condition of the rocks among which they lie. The mineral is generally somewhat graphitoid in character, rarely contains less than 15 per cent. of ash (the average percentage for a good seam being 18 to 20) and sometimes as much as 60 per cent. In the course of the great orogenic movements to which the rocks were subjected, the anthracite seems to have undergone a sort of recementation, and so can be got out in fairly-large blocks. At some localities in the valley of the Bormida di Calizzano, the mineral passes into an impure graphite, which was at one time actively worked.

It is estimated that the quantity of possibly-workable anthracite in the basin of La Thuile, where the best deposits on the Italian side of the frontier are concentrated, can hardly exceed one million tons; a trifle in comparison with the fabulous estimates previously put forward by some sanguine persons. The annual output in that basin at present is insignificant—some 250 tons or so. It may be here observed that, although on the French side of the frontier, in the Briançon, Maurienne and Tarentaise districts, the conditions (geological and economic) would appear at first sight to be more hopeful, the results so far achieved are not promising. The output there also is unimportant, in comparison with the enormous extent of country covered by the Carboniferous belt.

Considering, too, that the Italian mineral is useless for steam-raising or metallurgical purposes, the putting-down of plant on a large scale, or an attempt to send the coal away to any considerable distance, would be foredoomed to failure. It is held that these Italian anthracites can never be of more than local importance. It is quite possible, however, that workings on a small scale (especially in the basin of La Thuile) will prove remunerative, if judiciously managed.

The first two memoirs, of the seven above-mentioned, deal with the deposits in the Valle d'Aosta, the third with those of the Province of Cuneo, and the fourth and fifth with those of Western Liguria. In the sixth, the results of a chemical study of the anthracites of the upper valley of Aosta and of Western Liguria are set forth, 16 samples having been examined. The best yielded from 12 to 13½ per cent. of ash, and their heating-power was estimated at 6,400 to 6,500 calories. All contained a small proportion of sulphur: the proportions of hygroscopic water and fixed carbon were as extraordinarily variable as the proportions of ash. L. L. B.

MOLYBDENITE IN THE WESTERN ALPS, PIEDMONT.

Beitrag zur Kenntniss alpiner Molybdänitvorkommnisse. *By* G. Lincio. *Centralblatt für Mineralogie, Geologie und Paläontologie*, 1905, *pages* 12-15.

The author describes molybdenite occurring in association with iron- and copper-pyrites and magnetic pyrites, in much-disturbed, fractured, schistose gneisses, preferentially near the contact with limestone-inclusions, in the ravine of the Cherasca river, near Varzo, province of Novara. He has also examined hand-specimens of molybdenite-gneiss obtained from rocks which crop out on the road from Crodo to Baceno in the Antigorio valley: here again the molybdenite is associated with pyrites, magnetic and non-magnetic. Stress is laid on the fact that the occurrence of the mineral is limited in these localities to gneiss, and to that rock alone. L. L. B.

UNCOMMON CONSTITUENTS OF SARDINIAN BLENDE.

Su alcune Blende di Sardegna. *By* C. Rimatori. *Atti della Reale Accademia de Lincei*, 1904, *series* 5, *Rendiconti*, *vol. xiii.*, *pages* 277-285.

The author made chemical analyses of several specimens of Sardinian blende, from various localities. That from the cupriferous mine of Bena de Padru, the only Sardinian mine which at present offers any hopeful prospects in regard to the extraction of copper, was found to contain 0·1 per cent. of cadmium. Two specimens from the Montevecchio mines were found to contain respectively 0·79 and 0·76 per cent. of cadmium. On the other hand, the blende of Masua contains mere traces of cadmium, manganese and copper, and with its percentages of 65·25 of metallic zinc, 32·21 of sulphur and 0·28 of iron, may be regarded as an approximately-typical blende.

Not content with chemical analyses, the author proceeded to make careful spectroscopic analyses of blendes from the above-mentioned localities, and from three or four others in Sardinia, in order to determine whether they contain such comparatively-rare elements as indium, gallium, etc. Only in one case, at first, did he succeed in finding indium. This was in the blende of Riu Planu Castangias, which contains as much as 0·1231 per cent. of that element. In a second series of experiments, he was able to ascertain that very minute quantities of indium and of gallium are present in the blendes of Bena de Padru and Montevecchio. L. L. B.

FAHLORE OF PALMAVEXI, SARDINIA.

Il Fahlerz nella Miniera di Palmavexi (*Sardegna*). *By* C. Rimatori. *Atti della Reale Accademia dei Lincei*, 1903, *series* 5, *Rendiconti*, *vol. xii.*, *pages* 471-475.

The Palmavexi mine is about 3 miles distant from Iglesias, among limestones and calc-schists varying in colour from blue to white and in character from quartzose to dolomitic, but all lumped together locally as "the metalliferous limestone." The mine was formerly worked for lead- and zinc-ores, and recent investigations, made on behalf of the syndicate who now own the concession, have shown that deep-level workings would strike rich deposits of calamine and argentiferous galena. From east to west, a vein strikes through the property across these deposits: it appears to be parallel to the stratification of the limestone, is several feet wide, and may be termed a "bedded vein." In it was found the fahlore (which forms the chief subject of the author's remarks) associated with the predominating lead- and zinc-ores, and some copper-minerals. This is the first authenticated occurrence of fahlore in Sardinia: the mineral possesses a dark steel-grey colour and metallic lustre. Its percentage-composition is as follows: sulphur, 23·56; copper, 43·06; antimony, 23·66; zinc, 6·29; iron, 1·14; and silver, 1·64. It may be regarded as a sulph-antimonate of copper or tetrahedrite, most nearly approaching that variety of which the chemical formula is $4Cu_2S.Sb_2S_3$. One does not gather that it is present at Palmavexi in sufficient quantity to be of industrial importance. L. L. B.

CINNABAR-DEPOSIT OF CORTEVECCHIA, TUSCANY.

Geologische Verhältnisse und Genesis der Zinnoberlagerstätte von Cortevecchia am Monte Amiata. By B. Lotti. *Zeitschrift für praktische Geologie*, 1903, *vol. xi., pages* 423-427, *with* 4 *figures in the text.*

The Cortevecchia mine lies about 11 miles due south of the trachytic peak of Monte Amiata, half-way up the heights which form the right bank of the Fiora river. The strata of the neighbourhood consist largely of Eocene clays and marls, with great lenticles of Nummulitic limestone, overlying a series of Senonian limestones (white, red, and grey) with red fucoid-shales and ashen-grey marl-slates. The Cortevecchia cinnabar-deposit is especially associated with the faulted Ripacci lenticle of Nummulitic limestone. This is a granular rock, all but free from argillaceous constituents, much interbanded with chert and layers of nummulites: above and below, it passes into clayey and marly beds, and the chief concentration of metalliferous ore occurs near the junction in these passage-beds. Five different winnings have been opened up, and that on which the least progress has been made (on the Ripacci farmstead itself) promises to be the richest of all.

The cinnabar is found to have in part replaced the calcium carbonate of certain limestone-bands, and impregnates generally the marly layers interbedded with the limestones. The constant association with it of pyrites and gypsum suggests that it is genetically connected with sulphuric solutions. These probably welled up through a deep fissure, percolated through the crevices in the rock-mass, and in part corroded it. The upward and downward progress of the solutions would be arrested in places by the more or less impermeable argillaceous beds, and they would then spread out more or less parallel with the bedding, the cinnabar precipitated from them being chiefly found, as above stated, in the passage-beds at the hanging-wall and foot-wall of the limestone. The neighbouring ore-deposits of Cornacchino and Montebuono are analogous in this respect to the Cortevecchia deposit. L. L. B.

KIESELGUHR AND COLOURING-EARTHS OF MONTE AMIATA, TUSCANY.

Kieselguhr und Farberden in dem trachytischen Gebiet vom Monte Amiata. By B. Lotti. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 209-211, *with* 2 *figures in the text.*

The kieselguhr or fossil-flour of Monte Amiata is made up of the débris of microscopic siliceous algae and diatoms. It contains, as a rule, about 85 per cent. of pure silica, 3 per cent. of iron oxides, lime, alumina and magnesia, and 12 per cent. of water. The specific gravity varies from 0·08 to 0·30. The average thickness of the kieselguhr-deposit of Castel del Piano is about 15 feet. That, and the deposit at Bagnolo are actively worked at the present time. Intimately associated with these deposits of fossil-flour, are iron-ochres, varying in colour from a very pale to a very deep yellow, and containing also remains of diatoms. Two varieties of ochreous earth chiefly are worked at Monte Amiata—the yellow-ochre, which on burning turns deep red, and the bole. The former is used in the manufacture of sienna-yellow and burnt sienna, and the latter in that of burnt umber. These deposits were, all of them, evidently laid down in freshwater basins from

waters carrying silica and iron in solution. Siliceous and ferruginous springs are to this day active in the neighbourhood, and are probably the latest moribund phenomena of the vulcanicity which was at one time active there. L. L. B.

COPPER-ORES IN TRANSCAUCASIA.

Le Cuivre en Transcaucasie : Notes de voyage. By P. Nicou. *Annales des Mines*, 1904, *series* 10, *vol. vi., pages* 5-54, *with* 4 *figures in the text and* 1 *plate.*

This paper is the outcome of a journey made by the author in the autumn of 1903, in that portion of the Russian Empire which stretches southward from the Caucasus, between the Black Sea and the Caspian, to the frontiers of Turkey and Persia. In that area, metalliferous deposits are numerous, copper-, lead-, zinc-, manganese-, nickel- and cobalt-ores being of frequent occurrence; but various circumstances have combined to prevent hitherto the establishment of workings on any considerable scale, except in the case of the cupriferous and manganiferous ores. Despite the recent opening of the railways from Tiflis to Kars (1898) and from Alexandropol to Erivan (1902) transport-facilities are still lacking in several districts; moreover, the only coal-deposit worked in Transcaucasia, that of Tkvibuli (output in 1900: 63,400 tons), yields a mineral unsuitable for coking purposes, and either wood or wood-charcoal has, in many cases, still to be used as being the cheapest fuel, or at least as being that which is most readily available. The introduction of foreign capital is, however, putting a new complexion on things; and the prospective raising by the Russian Government of the already high duties on imported copper, is likely to resuscitate many little smelting-works which have been long abandoned.

The three most productive districts at the present time are those of Kedabeg, 26½ miles from the Dalliar station on the Tiflis and Baku railway; Allah-Verdi, on the railway from Tiflis to Alexandropol; and thirdly, the comparatively remote district of Zanghezur, 130 miles or so distant from Evlak station on the first-named railway. About 44 per cent. of the total output of copper in the Russian Empire is credited to Transcaucasia, the remaining 56 per cent. being supplied by the Urals, Siberia, Finland and the Kirghiz steppes; for 1902, the copper-ore got in Transcaucasia amounted to 106,718 tons, and the quantity of metallic copper produced there was 3,438 tons.

Passing then to the detailed description of the ore-deposits, the author commences with those of Zanghezur, which appear to have been worked, more or less, since time immemorial. Remote though the district be from the Russian centres of industry, it is but a journey of 65 miles (along the track followed by the camel-caravans) to Tabriz, still one of the richest towns in Persia; and it is curious to note that, in fact, the Zanghezur copper is still mostly absorbed by the Persian market. Some of the ancient workings went down to depths of 130 feet below the surface, but as the old miners only worked ores containing more than 15 per cent. of copper, their mines may well be re-opened with profitable results. The Zanghezur deposits consists mostly of quartz-veins mineralized in depth with various sulphides of copper and native copper, and with iron-pyrites (an invariable associate of the cupriferous sulphides); blende and galena are rare, but gold and silver occur in notable proportions. Towards the outcrops, that is, nearer the surface, the sulphides give place to oxides and carbonates. The

quartz-veins traverse, in some cases, andesites, in others porphyries; and there are also brecciiform cupriferous deposits intercalated between syenites and diorites. The methods of working and treating the ores are in some parts of the district old-fashioned and costly; in other parts, everything is being brought up to date, and there is some prospect of the abundant water-power available being utilized for electric installations. The author depicts in the most roseate hues the future prospects of the mineral-industry in this region, mentioning (among other factors) the existence there of a whole series of ore-deposits as yet untouched.

At Kedabeg, one may see the most considerable smelting-works at present in activity in Transcaucasia: but it is not a very accessible locality, and the road thither from Dalliar railway-station (26½ miles) rises in that distance from an altitude of barely 100 feet to one of 4,600 or more. The necessary fuel (a mixture of refined petroleum and *massiut*, or petroleum-residues) has, since 1897, been conveyed from Dalliar to the Kedabeg works by a pipe-line. The ore-deposits occur in the Copper mountain or Mis Dagh, near the contact of the quartz-porphyries with andesites or diorites, all of which rocks are believed to date back to the Jurassic period: the ore-bodies are thought to have been precipitated at a subsequent period, from waters percolating through cavities and fissures in the volcanic rocks. The chief ores are copper- and iron-pyrites, with blende and galena, occasionally magnetite, and always considerable proportions of gold and silver. The methods of extracting and refining the copper are described at some length, and we are told that in 1899 the amount of metal turned out by the Kedabeg smelting-works was 83 per cent. of the total Transcaucasian output, while in 1902 the competition of Allah-Verdi and Zanghezur brought it down to 44 per cent.

The district of Allah-Verdi lies in a very mountainous region, some 50 miles south of Tiflis. The mineral-industry, flourishing there in ancient times, was interrupted by the internecine wars which raged throughout the Caucasus for many generations; it has now taken a new lease of life, and coke is brought by railway from the far-off Donetz basin for the purposes of the smelting-works. In order to diminish the consumption of this fuel, the cost of which is extravagantly heightened by the freight-charges, a modified form of pyritic smelting has been adopted, the character of the ores not allowing of the application of that process in all its integrity. The crude ore is got from the three deposits of Akthala, Allah-Verdi and Chamluk: it occurs in pockets, among quartziferous andesites or among dacites, a notable enrichment being observed in the neighbourhood of the masses of gypsum which are frequently associated with the ore-deposits. At Akthala, near the uppermost portion of the deposits, gold- and silver-bearing galena is abundant. The method of treating the ores is described in detail; and the paper concludes with a brief description of other cupriferous deposits in Transcaucasia, some of which are perhaps of less importance, while the remainder must await the provision of transport-facilities before their undoubtedly vast wealth can be utilized. L. L. B.

THE ORE-DEPOSITS OF MOUNT DSYSHRA, WESTERN CAUCASIA.

Die Erzlagerstätten des Berges Dzyschra in Abchasien. By A. G. Zeitlin. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 238-242.

The Dsyshra ridge, one of the spurs of a lesser mountain-range which runs along the eastern coast of the Black Sea, parallel with the mighty

main chain of the Caucasus, is about 22 miles distant from the harbour of Gudout: from which, owing to the present condition of the tracks, it cannot be reached in less than 12 hours. The average altitude of the ridge above sea-level exceeds 8,000 feet, and the rocks of which it is made up are Jurassic limestones and dolomites. In these rocks occur veins and nests of argentiferous galena, zinc-blende, calamine, pyrites, and reefs of red and brown hæmatite. One of the calamine-deposits is practically 16 feet thick. In the fissures of the limestones, moreover, the occurrence of bitumen of very pure quality has been observed: it is exceedingly tough, extraordinarily free from sulphur, has a high melting-point, and has been experimentally applied with great success in the manufacture of patent-fuel (briquettes made from coal-dust). The various metalliferous ores have been analysed in several laboratories, with the following results: the brown hæmatite contains nearly 55 per cent. of metallic iron, and the red 68·5 per cent. The galena contains nearly 50 per cent. of lead and 8½ of zinc: whereas the blende contains 8½ per cent. of lead and 22·9 of zinc. With regard to the percentage of silver in the lead-ores, contradictory results have been obtained; but there is no question as to the presence of silver, the only dispute being as to its average proportion.

There seems to be no doubt that the ore-deposits would repay careful prospecting-work; many of the lead-ores, for instance, although not occurring in very thick veins on the whole, have a considerable horizontal and vertical extent. The calamine-blende ore-bodies are of such mass as to give every hope of successful working, and the lead-, zinc- and iron-ores of the Dsyshra river-valley are of very high purity. The lead- and zinc-ores are not intimately intermixed (an intermixture which often gives rise to metallurgical difficulties), but occur in separate bands or veins; and the treatment of the ores (more especially as scarcely any quartz or other refractory mineral is associated with them) in the smelter should be comparatively simple.

Much of the ore could be worked opencast, and even where underground workings are necessary these could be arranged by means of horizontal adits. The country-rock is soft, and therefore easily disposed of; the adjacent forests would furnish an abundant timber-supply; the rapid current and high fall of the mountain-streams could be made available for power-distribution. The one thing needed is the conversion of the present track along the banks of the Chüpsty into a good cart-road. The population of the district is scanty, but this is a drawback to which time will bring a remedy. L. L. B.

PETROLEUM-RESOURCES OF EUROPEAN AND ASIATIC RUSSIA.

Die Erdölvorkommen im europäischen und asiatischen Russland. By F. Thiess, *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate, 1904, vol. lii., pages* 12-16, *with a map in the text.*

The richest natural reservoirs of oil within the mighty Russian Empire lie in the country surrounding the Caucasus. Official estimates, based on geological investigations, of the probable productive area of which Baku is the centre, put it at 16,205 acres. Of this, barely one-sixth has been tapped so far. In common with other writers, however, the author points out that the average output of the individual wells has, on the whole, decreased: and, as, in order to make up for this diminishing productiveness, the bore-holes are put down year by year to greater depths, the costs of installation, main-

tenance and working have risen enormously. The *Official Gazette of Industry and Commerce* (*Torgovo Promyshlenaya Gazeta*) states the total output for 1900, 1901 and 1902, as 9,839,466; 11,049,948; and 10,434,060 tons respectively. The diminution recorded for 1902 has, however, but little bearing on the future of the Baku oil-field, as the workable area of it will undoubtedly be increased by draining certain bays of the Caspian, not to speak of the lakes of Romany and Sabunchy. On that portion of the first-named lake, which is already reclaimed, a Moscow syndicate has recently erected five derricks for oil-boring purposes.

The area of the rich oil-field of Grozny, 100 miles north-west of the harbour of Petrovsk, on the railway from Rostov to Vladikavkas, extends over 5,400 acres, and the output of petroleum in 1902 amounted to 556,920 tons. The chief difficulty met with in this field is the waterlogged condition of the strata that have to be passed through before striking oil.

In Daghestan, about 3 miles from the western shore of the Caspian, and 62 miles south of Petrovsk, an abundant oil-spring with a continuous flow was tapped in 1902, on the Bereki estate of the Imperial Treasury. This circumstance, and other evidence as well, points to the existence of a good reservoir of oil here: the conditions of working are very favourable. Other occurrences of petroleum are reported in Daghestan, as for instance, in the Talgin ravine, where out of a known oil-field of 6,752 acres, barely a sixth has been worked over as yet.

In the Kakhetinsky hills, which range parallel with the Caucasus from Tiflis south-eastward into the Apsheron Peninsula, petroleum has been tapped at several localities (the Chatma and Signakh deposits will soon be in full working by British companies), as also in the districts of Kutais and Elisavetpol, and at Anapa on the Black Sea. As a matter of fact all these occurrences of oil in the Caucasian region lie along a belt which stretches from the Sea of Azov to Batúm on the Black Sea.

It is a far cry from this region to the extreme north-east of European Russia, where, at Ukhta in the Pechora district that abuts on the Arctic Ocean, petroleum has been found, and the quality of the crude oil examined. The yield of illuminating-oils from it will not prove very large, but it will furnish a big proportion of residues suitable for heating purposes.

Turning now to Asia proper, the island of Cheleken, which lies opposite the long narrow tongue of land that stretches southward from the harbour of Krasnovodsk, the western terminus of the Central Asian Railway, proves to contain a quite considerable natural reservoir of oil. Petroleum, too, is reported from the provinces of Samarkand and Ferghana, and is actually worked for local use in the Nafta Dagh and the Buja Dagh. The province of Ferghana is especially rich in oil and ozokerite: petroleum is seen trickling out at the base of the hills, forming small pools, and covering with an iridescent film the waters of the streams. At Chemion, 12½ miles from the Vanovskaya railway-station, oil-springs were tapped by the Chinese in former days; and, thanks to the completion of the Samarkand railway, working has been restarted there, but by a European syndicate this time. At Mailissai, in the Namagan district, a newly-proved oil-field, covering an area of about 1¾ square miles, is being put up at auction by the Ministry of Agriculture.

The occurrence of petroleum on the Island of Sakhalin, north of the island-empire of Japan, is of importance for the Russian dependencies in the Far East. On the eastern shore, the Nutowo deposits were discovered in

1898: they include seven great oil-lakes, yielding an oil very similar to that of Baku, and quite free from sulphur and benzine. Petroleum-deposits in the north of the island were discovered and described in 1893.

Altogether, Russia possesses so many natural oil-fields that she can afford to regard with equanimity the eventual exhaustion of the Baku oil-wells. L. L. B.

TERTIARY BROWN-COALS AND ORE-DEPOSITS OF KRIVOI ROG, RUSSIA.

Materialien zur Geologie der Tertiär-Ablagerungen im Rayon von Krivoi Rog. By A. Faas. *Mémoires du Comité géologique, St. Pétersbourg*, 1904, *new series, No.* 10, 140 *pages*, 24 *figures in the text*, 1 *map and* 2 *plates.*

This memoir is primarily devoted to the geology of the Tertiary deposits of Krivoi Rog, and consideration of the useful minerals is exclusively confined to those which occur in these deposits. The oldest unaltered sedimentaries that crop out in the area, overlying the Archæan (?) crystalline schists and the gneisses, granites, etc., which form the original framework of the country, are almost certainly of Lower Tertiary age. These Palæogene deposits are chiefly grey and white sands and marls, and greenish or bluish clays. Next above come the Neogene shelly sands and oolitic shelly limestones, the uppermost of which date from Pliocene times. Overlying these is a great succession of reddish-brown clays (with gypsum- and marl-concretions) and loess-like loams of post-Tertiary age, as also fluviatile gravels and sands.

The cavernous brown hæmatites got in the southern part of the district, of excellent quality and easily smelted, and containing 56 per cent. of metallic iron, with only 0·12 of phosphorus and 0·11 of sulphur, are probably derived from the mechanical erosion and leaching-out of the ferruginous Archæan rocks that form the Ingulez ridge, at a time when that ridge was washed by the surf of the Lower Tertiary sea. Blocks of iron-ore are found scattered along the flanks of the ridge, but more abundantly on the steeper western flank than on the eastern. Actual beds of the ore vary enormously in thickness (from 20 inches to 30 feet) and in depth from the surface (3 to 140 feet), wherefore many of those that are shown on the map are not of immediate industrial importance.

The manganese-ores occur chiefly at the contact between the Lower Tertiary sands and clays and the Sarmatic Beds, that is, at a higher horizon than the brown hæmatites. Like the latter, the manganese-ores occur only in the neighbourhood of the ancient ridge of Ingulez, but perhaps extend over a larger area than the hæmatites: these manganese-ores, too, must have been primarily derived from certain Archæan crystalline rocks. The deposits so far known are not particularly conspicuous for abundance or quality, but as they have not been studied very minutely and have merely been discovered in the course of prospecting for iron-ores, it would be premature to assert that workable manganiferous deposits do not exist in the area. A sample, got a little distance away from the Kamienkowicz mine, assayed to 33·42 per cent. of metallic manganese, and the insoluble residues amounted to 22·72 per cent.

The brown-coal or lignite-bed (6 to 22 feet thick, with a general south-easterly dip), associated with some of the Lower Tertiary deposits, covers an area of 57 acres or so on the Novo-Pavlovskoye estate, and is there esti-

mated to contain 400,000 tons of mineral. But it is of poor quality, feeders of water are numerous, and the depth from the surface varies from 60 to 200 feet. A sample of lignite got from another locality yielded 42·32 per cent. of carbon, 12·8 per cent. of ash, and 3·66 per cent. of sulphur, with 5·36 per cent. of hydrogen (?). Volatile substances amounted to 52 per cent., and hygroscopic water to 11·78. The heating-power is estimated at 4,325 calories, and the yield of very pulverulent coke at 36·25 per cent.

The gypsum-deposits do not occur in such conditions as to make it likely that it would ever pay to work them. L. L. B.

IRON-ORE DEPOSITS OF THE BAKAL REGION, RUSSIA.

Bakalskiaya Miyestorozhdeniaya Zheliyesñikh Rud. *By* L. Konitshevsky *and* P. Kovalev. *Mémoires du Comité géologique, St. Pétersbourg*, 1903, *series* 2, *No.* 6, 126 *pages, with* 83 *figures in the text and* 2 *plates.*

The first-named author describes the deposits of the Bulandikha and Shuida hills in the district of Zlatóust, known to fame for more than a century.

The strata are mainly shales and limestones seamed by diabase-dykes, and folded into anticlines. Faults are numerous. The ore-deposits present the appearance of bedded masses intercalated among the shales with a roof of quartzite. The minerals are mainly brown hæmatite and spathose iron-ore, but turgite in crumbly masses also occurs. These ores are all very pure, and are indeed remarkable for their high percentage of metallic iron. The thickness of the ore-bodies is considerable, averaging 165 feet in the State Bakalsky mine and 100 feet in the Bulandinsky mine: in the latter, a diabase-dyke, decomposed to clay, occurs in the very midst of the ore. In the Uspensky mine, spathose iron-ore is seen passing into brown hæmatite and turgite. A short distance east, dolomitic limestones are seen immediately overlying the same shales as those which form the floor of the ore-deposit, an observation the importance of which is evident to the geological reader; especially when we learn that in the south-western part of the mine crystalline dolomitic limestones also occur, on the same strike as the ore-deposit. Other evidence is brought forward to establish the conclusion that the ore-deposits are the result of the chemical replacement of limestones, more or less dolomitic, by iron carbonates, the oxidation of which has yielded hæmatite, etc. In the absence of fossils the age of the rocks cannot be determined with certainty, but it is presumably Lower Devonian.

The ore-deposits of Mount Irkuskan, a ridge running east of and parallel to the Bulandikha and Shuida hills, are described by the second author as inexhaustible. They occur in a group of shales of various colours and limestones, believed to be also of Lower Devonian age. The brown hæmatite contains up to 65 per cent. of metallic iron, and is almost completely free from silica. The spathose iron-ore does not contain more than 60 per cent. of metallic iron, and impurities in the shape of magnesia and sulphur are present. The turgites are of a dark brownish-red, and contain still more magnesia than the spathose ore, but on the whole they approximate in composition to the typical formula $2Fe_2O_3H_2O$. The spathose iron-ore occurs generally immediately below the quartzite and passes into dolomitic limestones. Where the other two ores are associated with it, the succession in ascending order is (1) spathose ore, (2) turgite, and (3) hæmatite. There appears to be no doubt that turgite represents the intermediate

stage of the transformation of spathose ore into brown hæmatite. At the Elnichny mine, a deposit of spathose ore, 40 feet thick, is worked, while in the Ivanovsky mines nests of all three varieties of ore enclosed in the limestones are the chief object of mining operations. The richest deposits of the neighbourhood, bedded hæmatites and turgites (the two main beds are respectively 33 and 92 feet thick, and there are 9 other beds ranging in thickness from 10 inches to 6½ feet), are worked at the Tiazholy mines, while at the Gayevsky mine, a spathose ore-deposit (analogous to that of the Elnichny) is worked.

All the ore-deposits of the Bakal region may be regarded as belonging to Dr. Beck's category of *epigenetische Erzstöcke*: they are the outcome of the chemical reactions, which took place at some remote period between iron-bearing solutions and the carbonates of lime and magnesia of the limestones. L. L. B.

PLATINUM-DEPOSITS IN THE URALS, RUSSIA.

Notice préliminaire sur les Gisements de Platine dans les Bassins des Rivières Iss, Wyia, Toura et Niasma (Oural). By N. Vissotzki. *Bulletins du Comité géologique, St. Pétersbourg,* 1903, *vol. xxii., pages* 533-559 *and* 2 *plates.*

The region studied by the author is situated on the eastern slope of the Ural range; it includes the most considerable platinum-deposit hitherto discovered in the world, seeing that the placer extends uninterruptedly over a length of 80 miles, and yields annually from 40 to 50 tons of the precious metal.

The platiniferous belt of the Urals, geologically speaking, consists of four parallel bands striking roughly north and south: the westernmost of these, made up of crystalline schists, forms the watershed between Europe and Asia. The next band to the east comprizes olivine- and mica-gabbros, diallage-peridotites, diorites and altered syenites—all of them rocks which have been erupted from a great depth. The third band is made up of Lower Devonian sedimentaries, partly torn into, shattered and buried by diabasic eruptives: farther eastward eruptives of deep-seated origin (gneissose granites?) reappear; and finally we reach a belt of ancient rocks eroded by the action of the advancing sea of the Lower Tertiary age.

The area emerged from the waves as early as the Carboniferous period; consequently the accumulations of platinum, and in some localities of gold, in the surface-deposits were not swept away. They were concentrated later on in the alluvia—perhaps at the time of the most intense glaciation (Pleistocene?).

As is the case throughout the Urals, the primary source of the platinum is associated with the eruptive basic rocks; among these the platiniferous and auriferous dunite forms three great masses, shown on one of the author's maps. The other map illustrates the distribution, over the greater part of the Urals, of the platinum-bearing alluvia and the outcrops of platiniferous dunite—these being connected with the second of the four parallel bands mentioned above. Towards the south, the band becomes discontinuous, and finally dies out altogether: simultaneously with it disappear all the placers that can be reckoned as having any industrial importance. There is, it is true, in the Southern Urals, a small number of outcrops of platiniferous olivine-rock, but the percentage of platinum therein is small, and other metals of the group are generally associated with it, notably osmiridium. The annual output of the last-named is stated to average 385 troy ounces. L. L. B.

THE IRON-ORE DEPOSITS OF SCANDINAVIA.

(1) *L'Origine et les Caractères des Gisements de Fer Scandinaves.* *By* L. DE LAUNAY. *Annales des Mines*, 1903, *series* 10, *vol. iv.*, *pages* 49-106 *and* 109-211, *with* 23 *figures in the text and* 6 *plates.*

It is impossible in a brief abstract to do full justice to this exhaustive memoir, which is divided into five chapters, preceded by an introduction and followed by an appendix and a bibliography. The author visited Scandinavia in 1890 and again in 1899, with the view of studying on the spot the principal ore-deposits, and he acknowledges his indebtedness to the Swedish and Norwegian geologists and engineers, both for written and for verbal information.

The most important iron-ore deposits of Scandinavia form two well-defined groups—one situated north-west of Stockholm, including the Dannemora, Norberg, Persberg, Grängesberg mines, etc.; and the other in Northern Bothnia or Swedish Lapland, comprizing the much more recently-opened mines of Gellivaara, Kiirunavaara, Svappavaara, Rutivaara, etc. The deposits of the first group are mutually similar in many respects, while those of the second group are, geologically speaking, very dissimilar. The industrial primacy long enjoyed by the first group (the Dannemora mines dating from the thirteenth century) is manifestly shifting to the second group. In 1895, the annual iron-ore output for the whole of Sweden averaged 1,517,000 tons; but in 1903 the Kiirunavaara mines alone are reckoned to produce 1,200,000 tons, and the output from Gellivaara will probably have amounted to little less.

Geologically, the Scandinavian iron-ore deposits may be classified as follows:—

1.—Directly-segregated masses in immediate association with the basic rocks (gabbro, olivine-hyperite, nepheline-syenite) from which they are derived. The ores are frequently magnetites, sometimes titaniferous magnetite or titanic iron. Typical localities are Taberg, Kragerö, Ekersund, Lofoten, Rutivaara, Alnö, etc.

2.—Masses of debatable origin, possibly related in some way to the porphyries amid which they occur, as at Kiirunavaara and Luossavaara.

3.—Lenticular bodies occurring in "strings" amid metamorphic, Archæan, or Silurian rocks, probably originating from the recrystallization of sedimentary deposits, as at Svappavaara, Gellivaara, Grängesberg, Norberg, Persberg, Dannemora, Dunderlandsdal, etc.

The author gives a detailed description of these three classes of deposits in the order named. He compares the conditions, under which the segregation-deposits originated, to metallurgical processes, taking place in the depths of the earth. He imagines a molten mass of metal being churned up with steam in the presence of hydrocarbons, sulphuretted hydrogen, or hydrochloric acid, with the result that iron-ore free from phosphorus was generated, the phosphorus having passed off in the slag. He suggests that native iron probably exists within the globe at inaccessible depths.

After showing how very exceptional are the characteristics of the Kiirunavaara-Luossavaara deposits, differing indeed entirely from any others in Scandinavia, the author remarks that a chronological succession can be traced in them. It looks as if the ore had been deposited by sedimentation between two periods of submarine eruption of porphyries, these porphyries themselves being intercalated in a pre-Cambrian (?) series of conglomerates, shales and quartzites. The minimum quantity of iron-ore in sight at

Kiirunavaara and Luossavaara is said to amount to 233,000,000 tons. The ore is an almost absolutely pure mixture of magnetite and apatite, with a small proportion of titanium, and very compact in structure. The percentage of phosphorus generally ranges from 1 to 4; but it is said that a great quantity of ore can be got, containing only from 0·1 to 0·8 per cent. of phosphorus. The percentage of sulphur varies between 0·05 and 0·08, and that of titanic acid between 0·32 and 1·5.

A very detailed description is given in the third chapter of the well-known deposits of Gellivaara, Grängesberg, Norberg, etc., and the author then devotes a few pages to the newly opened-up deposits of the Dunderlandsdal, etc., in Northern Norway. It is expected that the export of ore from these mines will, in 1905, be at the rate of 750,000 tons per annum. The ore-body, a mixture of quartz, hæmatite and magnetite, with which are associated garnet, epidote, some hornblende, pyroxene, etc., is defined as a ferruginous quartzite, passing gradually into barren quartzites comparable with the itabirites of Brazil. It occurs amid a complex of mica-schists and marbles, which are believed to represent a syncline of metamorphosed Cambro-Silurian strata. The percentage of metallic iron varies between 30 and 40, rarely attaining 55: the hæmatite is 10 times more abundant than the magnetite. Manganese occurs in very variable proportions, ranging from zero in the southern area to 3 or 5 per cent. at Ofoten and Salangen. Phosphorus, in the form of apatite, averages 0·2 per cent.; sulphur occurs in very small proportions, and titanium is absent.

The fourth chapter is taken up with the consideration of the part played by phosphorus in the Scandinavian iron-ores generally. The author points out that in most sedimentary formations the circumstances which have brought about the precipitation of iron have also favoured the concentration of phosphorus, a concentration which appears to attain its maximum in the ores of Lapland and Grängesberg. Perhaps both iron and phosphorus are derived from the erosion of very ancient folded rocks, which were really the "slag" remaining over from those deep-seated processes of natural metallurgy to which reference has already been made. In the appendix, a brief description is given of the methods by which the iron-ores and the apatite are separated and sorted out at Luleå and Grängesberg.

(2) *Bericht über eine im Sommer 1903 nach den Eisenerzvorkommen an der Ofotenbahn ausgeführte Studienreise.* *By* Dr. Hecker. *Zeitschrift für das Berg-, Hütten- und Salinen-wesen im Preussischen Staate*, 1904, *vol. lii., pages* 61-85 *and* 5 *plates.*

Of the total output of iron-ore in Sweden for the year 1901, that is, 2,793,566 tons, the Gellivaara mines produced 38·6 per cent. and the Grängesberg mines 23·6 per cent. (Nothing had yet been forthcoming from Kiirunavaara in 1901 and 1902, regular systematic working not having been started there until 1903). Of the above-mentioned total output 89·7 per cent. consisted of magnetite and 10·3 per cent. of hæmatite. The export of iron-ore from Sweden during the same year amounted to 1,761,007 tons, no less than 1,477,124 tons of which were taken by Germany, who seems to be in this respect consistently Sweden's largest customer. But the near future may see a shifting of the balance.

The deposits of Kiirunavaara, Luossavaara and Gellivaara constitute by far the most important occurrences of the kind in Scandinavia; the working of the first two on a large scale could not well get into full swing until completion of the railway to Narvik on the Ofoten Fiord, at the end

of 1902. The first cargo of ore was shipped from there on January 2nd, 1903, and within the first six months of the same year the Grängesberg Company bought up most of the shares of the Gellivaara Mining Company and of the Luossavaara-Kiirunavaara Company, thus forming a huge trust, managed from the central offices in Stockholm.

The great Kiirunavaara deposit strikes from north to south along a range of hills, in such wise that all the hilltops consist of ore, which has better withstood erosive agencies than the neighbouring country-rock: it really consists of three belts separated by narrow partings of rock, and the total length is about 3 miles, while the average breadth exceeds 300 feet, and the average thickness or depth is about 230 feet. The dip, invariably eastward, ranges from 50 to 70 degrees, and borings have proved that the thickness of the ore-body diminishes with the depth. Taking this into account, the minimum estimated mass of the deposit above the level of the neighbouring Luossajärvi Lake (the surface of which lies at an altitude of 1,640 feet) is 215,000,000 tons, but the more probable figure is now believed to approach 300,000,000 tons. The country-rock is porphyry, which itself forms a sort of island amid bedded sedimentary rocks, mainly slates and conglomerates. The ores (magnetites) are very compact, much harder than the generality of Swedish iron-ores, and practically free from all impurities, except apatite. The proportion of this varies greatly, but so far four well-recognized grades of ore are worked, and are distinguishable without any special sorting: the best of these grades contains from *nil* to 0·04 per cent. of phosphorus and 69 to 70·5 of metallic iron, the corresponding percentages in the worst grade being from 3·5 to 6 per cent. of phosphorus and 54 to 57 of metallic iron. Dr. Lundbohm regards the deposit as the product of magmatic differentiation, that is, of eruptive origin; while Prof. Vogt holds that it was deposited first of all by chemical precipitation as hæmatite, and was subsequently altered into magnetite by contact-metamorphism. The author adduces reasons in favour of the former view, and shows how the latter is in conflict with the available evidence.

The Luossavaara deposit lies on the opposite (northern) bank of the Luossajärvi Lake: on account of the thick covering of drift by which it is largely mantled, it has not been so minutely studied as that of Kiirunavaara, and investigations conducted with the magnetic needle have failed to reveal a connection between the two deposits. That of Luossavaara is believed to constitute a huge lenticle, nearly a mile long and from 100 to 165 feet thick; the easterly dip is very steep, and the minimum mass of ore above lake-level is estimated at 18,000,000 tons. Most of the magnetite corresponds in quality to type No. 2 of the Kiirunavaara ore: containing from 0·05 to 0·1 per cent. of phosphorus and from 68 to 69 per cent. of metallic iron, and it also contains rather more titanium. The country-rock is again porphyry, and the ore-deposit is undoubtedly of the same eruptive origin as that of Kiirunavaara.

The climatic conditions are not quite so unfavourable as might have been expected at so high a latitude (68 degrees north), but the plague of the millions upon millions of mosquitoes which breed in the neighbouring marsh-lands is almost unbearable in the summer.

The ores are worked opencast, and are got mainly by shot-firing with dynamite, the Ingersoll compressed-air drill being the appliance finally selected for use. The haulage and loading arrangements are of the most

modern description. For distribution of power and lighting purposes there is a power-station provided with three Lancashire boilers, and with room for two more. The exciters of the two dynamos are driven by De Laval steam-turbines, which make 3,000 revolutions in a minute. The two air-compressors furnish air at 5 atmospheres, and this is distributed through the workings by wrought-iron pipes 8 inches in diameter. The electric current is at a tension of 2,000 volts, and besides driving machinery of various kinds, it serves to light the mines and the railway-station and a portion of the town of Kiiruna. The number of people employed is from 500 to 600, working in 8 hours shifts. The prime cost of a ton of ore works out at about 2s. 3d., but with a larger output it is hoped to reduce this soon to about 1s. 10½d.

Short descriptions are given of the Ofoten railway, and of the increasing facilities for shipping at the harbour of Narvik, and the author then proceeds to give an account of his visit to the well-known mines of Gellivaara. Only one of these (Koskullskulle) lies outside the scope of the great Swedish trust previously mentioned and belongs to a company, most of whose shares are held in Austria. The ore-deposits (magnetites and subsidiary hæmatites) lie in a hill about 3 miles north of Gellivaara, and 46½ miles north of the Arctic Circle; they conform to the normal type of Swedish iron-ore deposits, and the amount of ore in sight is estimated at 100,000,000 tons. The country-rock is a distinctly bedded, pinkish hälleflinta-gneiss, but neither it nor the ore is often seen to crop out at the surface, being generally mantled over by the all-pervading Glacial Drift; the whole mass of rock is seamed by numerous intrusive dykes, mostly pegmatitic and granitic, but also syenitic at the Koskullskulle mine. The lenticles of ore form two distinct belts, the northernmost being the main one: the greatest thickness of ore (maximum, 492 feet) is observed in the Tingvallskulle lenticle, and the dip varies between 50 and 70 degrees southward. The structure of the ore is generally crystalline-granular, and crumbles easily into its constituent granules, but at Koskullskulle the mineral is finer-grained and tougher. Apatite is almost the sole impurity, and as its proportion in the ore diminishes, so does the mineral gain in toughness. There are six recognized grades of ore, the highest of which contains 69·09 per cent. of metallic iron and 0·021 per cent. of phosphorus, while the lowest contains 59·10 of iron and 1·9 per cent. of phosphorus. Most of the output is fifth- and fourth-grade ore, but the Koskullskulle mine produces 70 per cent. of first-grade and 30 per cent. of third-grade ore. As at Kiirunavaara, the ores are sorted by mere inspection on being loaded into the haulage-wagons, and here again this rough sorting, when tested by chemical analysis, proves to be remarkably accurate.

The climatic conditions are somewhat more favourable than at Kiirunavaara, and the country is covered with a thick growth of conifers; but the depressions are occupied by vast swamps, and the mosquito-plague becomes really terrible on hot summer-days. The system of working the ores is very simple, "almost primitive"; hand-drilling has been found more suitable and cheaper than electric drills, and the mass of ore is got down by shot-firing. Although the workings are mainly opencast, deep-level workings have been started at various points (especially for the cold season) as in them the miners are better shielded from the rigours of the Arctic winter, and the levels are lighted by electric arc-lamps. The total output of ore in 1902 exceeded 1,000,000 tons. The mines have direct railway com-

munication with Gellivaara, and thence with the seaport of Lulea on the Gulf of Bothnia: this harbour is, however, free from ice for only about 5 months in the year, wherefore the winter-output is kept stacked at the mines until navigation is open, and the condition of the ore is not improved thereby. L. L. B.

SABERO COAL-FIELD, SPAIN.

Descripción de la Cuenca Carbonífera de Sabero (Provincia de León). *By* L. Mallada. *Boletín de la Comisión del Mapa geológico de España*, 1900, *series* 2, *vol. vii., pages* 1-65, *with* 8 *figures in the text and* 1 *plate.*

The abundance of the coal-outcrops in this district of the province of Leon, together with the occurrence in the same neighbourhood of considerable iron-ore deposits, gave rise to the hope, some 60 years ago, that Sabero would ultimately become the centre of a great metallurgical industry. The mines were most actively worked between 1850 and 1860; yet in 1868 mining operations were abandoned all but completely, and it was only from 1890 onwards that new projects of railway-construction encouraged the capitalists of Bilbao to form syndicates for the purpose of re-starting active work in the Sabero coal-field. From the railway-station of La Ercina to the central point of this coal-basin, which is one of the longest and narrowest in Castile, the distance is barely 2 miles. From the neighbourhood of Las Bodas the coal-belt extends for some 12 miles to beyond Fuentes, while its breadth varies from a few feet to rather more than ½ mile, the total area being estimated as equivalent to 5,263 acres. To the north and south, the Coal-measures are bounded by Devonian strata, but in one or two localities they abut direct upon the underlying Cambrian. It is chiefly in the Devonian quartzose grits that occur the iron-ores referred to above: they contain between 20 and 40 per cent. of metallic iron. The occurrence of these ores is connected by some geologists with certain intrusive igneous rocks, scattered bosses of which are seen in the very centre of the coal-basin, as well as among the Devonian sedimentaries. In the last-named, copper, lead, and zinc-ores have also been proved. All the Palæozoic strata in this region have been subjected to much disturbance and dislocation. On the north-east and west, the coal-field is bounded by newer strata, belonging to the Cretaceous series. The lowest of these newer beds, described as "kaolin," is of great industrial importance, as it has not only been proved in the area dealt with here, but is a characteristic associate of the Spanish coal-basins for a distance of 93 miles or more, and occupies a belt varying in breadth from 70 to 330 feet. The Cretaceous beds show signs of great dislocation also, and it is pretty certain that the coal-field will be found to extend below them over a greater area than is generally suspected at present. The coal-measures themselves consist of alternating sandstones and shales, with conglomerates towards the base, made up of more or less angular fragments of Devonian limestone. A detailed description is given of the coal-basin, with many records of the succession and lie of the strata and the thickness of the seams, as revealed in the mine-workings, etc. The richest portion of the field lies between the meridians of Sotillos and Saelices, but the seams vary greatly as to quality and texture of coal. More than 50 per cent. of them yield a mineral which has to be carefully sorted into different grades, and gives much trouble also in the matter of washing. The northern group of seams are of regular

occurrence and vary in thickness from $2\frac{1}{4}$ to $8\frac{1}{4}$ feet: the other group comprizes seams which are very irregular, but attain extraordinary thicknesses (from 13 to 80 feet or more). There is not a mine which does not show repeated dislocation of the strata, with changes of strike and dip. This latter is generally steep (between 50 and 70 degrees, and in some cases steeper than that); the general strike is east and west.

After tabulating analyses published in 1856 and in 1885 respectively, the author gives further analyses of four specimens of coal which he himself obtained. In these the volatile matter varies from 18 to 23·05 per cent., and the ash from 2·3 to 8·10 per cent. The coal is considered to be the best that is found in Castile. As to quantity of available mineral, the author discusses at great length the various calculations entered into by geologists and engineers, and finally decides on 48,000,000 tons as the probable amount contained in the Sabero basin. He regards this, however, as a very moderate estimate. Including sorting and washing, the prime cost of the coal is 11 pesetas, or 8s. 3d. per ton; of coke, 16 to 18 pesetas, or 12s. to 13s. 6d.; and of patent fuel or briquettes, 18 to 19 pesetas, or 13s. 6d. to 14s. 3d. The statistics of output appear to be incomplete, but in the case of one of the most important companies in the field (owning three-quarters of the total area) the average annual output is stated at 110,000 tons. The author considers that a fusion of the various companies would not only bring about great economies in the cost of management, etc., but would conduce to greater efficiency of working and hence to an increase of output. Certain northerly extensions of the coal-field (Santa Olaja, Ocejo and Argovejo) are described in detail. The last-named of the three alone is reckoned to contain 2,000,000 tons of coal.

L. L. B.

MESOZOIC BROWN-COAL- AND ORE-DEPOSITS IN SPAIN.

Explicación del Mapa geológico de España: Sistemas Infracretáceo y Cretáceo. By L. MALLADA. *Memorias de la Comisión del Mapa geológico de España*, 1904, *vol. v., pages* 458-502, *with* 8 *figures in the text.*

The author of this magnificent memoir remarks that, of the whole Mesozoic series in Spain, the Cretaceous and Infra-Cretaceous systems are the richest in useful minerals.

He describes first of all the coal-fields of the province of Teruel: here coal occurs at three distinct horizons, the lowermost being associated with *Orbitolina*-beds, the middle with *Trigonia*-beds and the uppermost with equivalents of the Cenomanian sandstones, which are overlain by limestones containing *Ostrea flabellata*. The coal-basin of Utrillas is 10 miles in length and 3 miles in utmost breadth, and of elliptical shape. The seams mostly crop out in the southern portion, and have a dip varying between 20 and 25 degrees. They are 10 in number, with a total thickness of 60 feet, including two seams of jet. Two or three seams of lignite of good quality have also been proved at some localities. North-north-east of the basin just described lies that of Gargallo, occupying a triangular area of about 10 square miles, and containing fewer coal-seams, and those of later date (basal Cenomanian). There are at most four seams, very near together, each about 40 inches thick, and several bands of pyritous lignite varying in thickness from $3\frac{1}{4}$ to 5 feet. Cenomanian coal also characterizes the basin of Ariño: there are three seams, of a thickness varying between 10 and 23 feet, yield-

ing a mineral which burns with a long flame, but crumbles away to dust on exposure to atmospheric agencies. The coal-seams of the basin of Aliaga, about seven in number, are mostly of earlier date than those of Utrillas, and are of good quality. On the whole, although the coal-fields of Teruel give hopes of a brilliant future, the amount of mineral in sight has been much exaggerated. Seven specimens from Utrillas and five from Gargallo have been analysed, and are found to contain from 41 to 45 per cent. of carbon, and 48½ to 49½ of volatile substances; they yield from 6 to 9 per cent. of ash; their heating-power varies between 4,700 and 5,000 calories, and their specific gravity between 1·3 and 1·4.

Amid the uppermost Cretaceous (Danian) of the province of Barcelona occur four coal-basins, the most important of which is that of Vallcebre: it contains as many as 15 seams of brown coal, and one of these seams alone is calculated to yield 40,000,000 tons or more of the mineral. The coal from this seam contains from 52 to 53 per cent. of carbon, 41 to 43 of volatile substances, and yields from 4 to 7 per cent. of ash. Its heating-power is estimated at 5,200 calories, and it burns easily with a long flame. The mineral from some of the seams appears capable of being turned into coke; but, as a rule, it is found necessary to mix it with bituminous coal for coke-making purposes.

Lignite-seams are worked in the province of Santander; they were also worked at one time in Álava, and the seams there are so thick that it will probably be found profitable one day to restart the workings. Brief mention is also made of the lignites of Guipúzcoa, Soria, and other provinces.

The principal deposits of jet occur in the Turonian basins of Utrillas and Gargallo, in the form of lumps of varying size scattered through clay-beds some 2 or 3 feet thick. The output has of late years been reduced to quite insignificant proportions.

Although, in the province of Álava, the main occurrences of asphalt are in the Eocene limestone, there are also deposits of it in the Cretaceous sands and sandstones. These are apparently worked with some success.

With regard to iron-ores, the first rank is of course taken by the province of Biscay. The *vena, campanil* and *rubio* grades of hæmatite of Somorrostro have formed the subject of a considerable literature; but the formerly less famous spathic iron-ore, which occurs along with them, is now being worked on a gigantic scale, and after calcination, is exported to foreign countries. The author gives many quotations from Mr. Adán de Yarza's well-known *Geological and Physiographical Description of the Province of Biscay*, and horizontal sections taken in sundry mines. Estimates of the amount of iron-ore in sight at Somorrostro vary considerably, but it certainly far exceeds the 40,000,000 tons estimated by Mr. Goenaga. Certain other iron-ore deposits of Biscay are described, and the author then refers to their westward prolongation into the province of Santander, the most important localities in this connection being Setares and Dicido. The hæmatites of the Asturias and of Soria were worked in times gone by, and deposits that might well be worked occur among sandstones in the Aliaga district of Teruel.

The best zinc-ores (blende and calamine) in the province of Santander occur at Reocín and Mercadal. At both localities, calamine is mined, containing 40 per cent. of the metal, and is enriched by calcination on the spot to 56 per cent. The zinc-ores of Biscay are of less importance: three vertical veins carrying blende, calamine and galena, and ranging in thick-

ness from 2 to 10 feet, are worked at Lanestosa, and a similar one is worked near Matienzo. The blende from these contains 50 per cent. of zinc, and the more abundant calamine assays (after calcination) to 45 per cent.

The principal lead-ore deposits occur at Villareal, in the Province of Álava, where several veins of galena associated with blende are or have been worked. Those of Biscay, Guipúzcoa, Soria, etc., are apparently too poor to repay systematic working.

Very pure pyrolusite occurs in pockets in the Crivillín district of Teruel.

Petroleum occurs, in comparatively small quantities, about 1¼ miles distant from Huidobro, in the province of Burgos, and is utilized locally. The other mineral-occurrences enumerated by the author are, on the whole, either of very little industrial importance, or else have been worked out.

L. L. B.

ORE-DEPOSITS IN THE SIERRA MORENA, SPAIN.

Die Erzlagerstätten von Cala, Castillo de las Guardas, und Aznalcollar in der Sierra Morena (Prov. Huelva und Sevilla). *By* C. Schmidt *and* H. Preiswerk. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 225-238, *with* 7 *figures in the text.*

The western portion of the Sierra Morena, in Southern Spain, consists largely of steeply-dipping Palæozoic slates and limestones, striking on the whole east and west, and traversed in many places by masses of eruptive rock. The far-famed ore-deposits belong to two distinct belts: (1) the southern, 143 miles long and 12½ miles broad, in which lenticles of pyrites and manganese-ores predominate; and (2) the northern, in which oxidic iron-ores, such as magnetite and hæmatite, predominate, but are in places associated with pyrites.

The authors describe first of all the deposits in the Sierra del Venero, near Cala (province of Huelva) belonging to the northern belt, which they visited in September, 1903. The summit of the Sierra (2,380 feet above sea-level) actually consists of hæmatite-crags, and the outcrops of iron-ore extend for some two-thirds of a mile through Cambrian slates, close to the southern margin of a granite-massif. The slates here have been much altered by contact-metamorphism, whereas on the northern margin of the intrusion the slates are far less altered, and are barren of iron-ore. The ore is chiefly magnetite associated with pyrites, and is a typical example of a contact-metamorphic deposit, disposed in lenticles conformably interbedded with the altered slates. The outcrops at the actual surface are almost universally made up of hæmatite, considerable surface-outcrops of magnetite and pyrites being observed only at two points. The average percentage in metallic iron of the surface-hæmatite is 50. Four metalliferous zones in this area are plotted out and described, on the strength of the evidence obtained from the mine-workings, and the amount of ore in sight is estimated at 4,000,000 tons of hæmatite (50 per cent. of metallic iron, 4,000,000 tons of magnetite (about 60 per cent. of metallic iron) and 1,000,000 tons of cupriferous pyrites (about 6 per cent. of metallic copper). But the available evidence leads the authors to believe that, over and beyond the mass of ore already proved, fully as much again will be found to exist in the Cala district, and of quality in no wise inferior to the ore which is now worked. The conditions of working are extremely favourable, and at least 4,000,000 tons of iron-ore can be got by opencast. No

difficulties, even in the underground workings, are likely to be experienced in the matter of ventilation or from water-inflows. Much space is devoted to a discussion of the contending views of various writers in regard to the genesis of contact-metamorphic ore-deposits, the present authors finally concluding that the iron of the Sierra del Venero was originally derived from the intrusive granite.

They then describe the pyrites-deposits of Castillo de las Guardas and Aznalcollar (province of Seville) belonging to the southern belt: these are the easternmost mines of that portion of the Sierra Morena, and, although mentioned by Mr. J. H. Collins, they have on the whole received scant attention from the majority of writers.

Three great pyrites-lenticles intercalated among Silurian slates dipping steeply northward, with a great granite-massif close by on the south-east, are found at Castillo de las Guardas. The westernmost lenticle is accompanied along its northern margin by a sill of diabase. The outcrops are indicated very clearly by the ferruginous gossans, and from the north-western lenticle alone (the only one worked so far), more than 2,000,000 tons of ore could be got by opencast working merely, if the adjacent country-rock were blasted away (as is done at Rio Tinto). The average composition of the pyrites is 50 per cent. of iron, 48 per cent. of sulphur, and 2 per cent. of copper, and the mineral is remarkably free from arsenic.

About 2 miles east of the village of Aznalcollar, which itself lies about 19 miles north-west of Seville, two great belts of pyrites are intercalated among the Palæozoic slates; in their immediate vicinity are numerous sills of quartz-porphyry, sometimes conformably interbedded with the slates, sometimes cutting down through them or overlying them. The whole formation is overlapped by fossiliferous Miocene limestones and conglomerates, which have been eroded away over large areas. The ore-bodies are discoidal or lenticular, and comparatively flat-bedded: each consists of two distinct portions, the southern and smaller portion being rich in copper, and the northern and bigger portion being poor in that metal. The highly-cupriferous masses soon pinch out in depth, and have been all but worked away; while the less cupriferous masses increase with the depth in considerable proportions, say from a thickness of 50 feet near the surface to one of 85 feet at a depth of 360 feet. The mass of ore still unworked is estimated at about 7,000,000 tons, containing only about $\frac{1}{2}$ per cent. of copper, with 0·6 per cent. of arsenic. Evidence is adduced to prove the association of the ores with the quartz-porphyry intrusions, and then a discussion is opened on the genesis of the pyrites-deposits of Southern Spain generally. This question assumes the greater importance that the Spanish deposits are typical of whole groups of deposits occurring in various parts of the world. It is to be noted, by the way, that the contact-zone of metamorphism due to the Cala granite-intrusion is far more extensive and "intense" than that determined by the porphyries of the Rio Tinto belt. The Spanish deposits are compared with those of the Island of Elba, Campiglia Marittima, Massa Marittima and Gavorrano, in Italy, and final stress is laid on two points: (1) the pyrites-magnetite reefs in the north of the Sierra Morena must be taken into account when one is studying the origin of the pyrites-lenticles in the south: and (2) it has been ascertained beyond doubt, in one case at least, that the quartz-porphyry [of Aznalcollar] with the accompanying bands of pyrites cuts through the slates. L. L. B.

ROCK-SALT DEPOSIT OF CARDONA, SPAIN.

Criadero de Sal de Cardona. *By* D. L. M. Vidal. *Boletin de la Comisión del Mapa geológico de España*, 1900, *series* 2, *vol. vii.*, *pages* 149-155, *and* 2 *plates*.

This deposit, associated, as is so frequently the case, with gypsum, forms a great mass in the neighbourhood of Cardona, in the district of Manresa, Catalonia. The beds are highly folded and contorted, but the salt is very pure, especially in the lower portion of the mass. The question of age is still in dispute. While many geologists believe that the deposit is Triassic, others, and the author among them, hold that it probably dates from the Oligocene division of the Tertiary Era. It is pointed out that the salt-deposit of Vilanova de la Aguda, in the province of Lérida, some 22 miles away, is of Oligocene age, and that the splendid rock-salt of Remolinos, in the province of Zaragoza, is Miocene. In fact, all the known rock-salt deposits in Spain are of early Tertiary age.

The paper contains no particulars as to output, methods of working, etc.

L. L. B.

BITUMEN-MINES IN ALBANIA, TURKEY.

Note sur les Mines de Bitume exploitées en Albanie. *By* A. Gounot. *Annales des Mines*, 1903, *series* 10, *vol. iv.*, *pages* 5-23.

These mines are situated in the sandjak of Bérat, in the vilayet of Janina, and the village of Selenitza (the local centre of the industry) is 9½ miles or so distant from the harbour of Vallona on the Adriatic. The district is rugged and mountainous in character; the strata are of Tertiary age, comprizing thick beds of clay (abundantly fossiliferous), shelly sands, and bands of gypsum, resting upon a basement of very tough, blackish limestone.

The author distinguishes four varieties of bitumen in these deposits. First of all, the "dull solid bitumen" occurring in scattered, irregular pockets, generally near the surface of the ground, and ranging in thickness from a few inches to several feet. A chemical analysis shows its percentage composition to be as follows:—Bitumen, soluble in carbon bisulphide, 72·69; water and loss at 212° Fahr., 9·12; ash, 17·19; and organic substances, 1. This may be compared with the Trinidad mineral, which contains on an average 34 per cent. of bitumen.

Next he describes the "lustrous solid bitumen." Unlike the variety just dealt with, it occurs over a restricted area, and only in the dark limestone. It is always in perfectly-distinct, mutually-parallel, nearly-vertical veins, striking north 50 degrees east. That it was originally deposited from above, and not injected from below, is proved by the fact that nowhere does it continue in depth. At 50, or at most 70, feet below the surface, all trace of it disappears. The lustrous bitumen has a still finer conchoidal fracture, and is of a richer black, than the dull variety. No mineral exactly like it is known to occur elsewhere; its composition is as follows:—Bitumen, soluble in carbon bisulphide, 98 per cent.; water given off at 212° Fahr., 1·4; carbonaceous substances, 0·2; loss and undetermined substances, 0·4. The mineral is often called after the village of Romsi, near which most of it is got.

The third variety is the liquid bitumen, which occurs in a low-lying area, at the base of the mountain-massif, near the Viussa river: the workings were flooded out after heavy rains in the winter of 1895-1896, and the

river has practically obliterated all traces of them. Fortunately the author had thoroughly investigated the area in 1894; and he is able to state that the liquid bitumen came up through cracks in the ground, where it partly solidified in the form of miniature volcanic cones, from a viscous mass of bitumen flowing along a sort of subterranean pebble-bed down from higher altitudes. The composition of the liquid bitumen was found to be as follows:—Bitumen, soluble in carbon bisulphide, 96·4 per cent.; insoluble matter, 1·9; carbonaceous substances, 1; loss and undetermined substances, 0·7.

The fourth variety, asphalt, is abundant at Selenitza, but does not repay working, on account of the difficulties and cost of transport. However, it comes in handy as fuel in a locality where coal costs 32s. a ton: this asphaltic fuel, known locally as *javor*, has the following composition:—Bitumen, soluble in carbon bisulphide, 39 per cent.; water given off at 212° Fahr., 2·85; carbonaceous substances, 16·8; insoluble residues, 40·7; loss and undetermined substances, 0·65.

The wasteful and careless methods of former generations of miners have made it practically impossible to work over the same ground again in a systematic manner, and many thousand tons of bitumen must needs remain untouched. At other points, methodical working on a small scale is going on, under the author's direction apparently: in some cases by means of adits, in others by means of small shafts. The mineral is hand-picked at the mines, and again re-sorted at Selenitza. The best grades are sent off as they are, while the lower grades are freed of their impurities by fusion. Labour is cheap, the daily wage of a workman averaging 5 piastres, or say 10d. The author is of opinion that the Albanian miner is exactly worth his pay, and no more. The transport of the mineral by pack-mules or pack-horses to the harbour of Vallona, along rough paths, costs about 6s. 10d. per ton: there, the bitumen is mostly loaded on Italian sailing-vessels. It may be mentioned that roads suitable for wheeled traffic are non-existent in the Selenitza district. L. L. B.

CINNABAR-DEPOSITS OF KARA-BARUN, ASIA MINOR.

Notizie sul Giacimento Cinabrifero di Kara-Barun nell' Asia Minore. By G. D'Achiardi. *Atti della Società Toscana di Scienze Naturali, Processi verbali*, 1903, *vol. xiii., pages* 173-176.

In the north-eastern portion of the peninsula of Kara-Barun, in the province of Smyrna, is a highly-metamorphic dark schist, traversed by a quartzose brecciated rock, which contains from $2\frac{1}{4}$ to $2\frac{1}{2}$ per cent. of mercury. A shaft was sunk some 65 feet down into this rock, which strikes north and south; and about halfway down a heading was driven east and west. It cuts through about 26 feet in cinnabar-bearing rock, and then enters the metamorphic schist (on the west), which itself is found to contain about 0·3 per cent. of mercury. On the east, the cinnabar-bearing breccia is flanked by some 10 feet of yellow and red ochreous deposits, poor in cinnabar but very rich in nodules of pyrites. The schist has been proved for more than 300 feet to the eastward, and then abuts against a Cretaceous Hippurite-limestone, while on the west it is suddenly cut out by basaltic eruptives. Small cinnabar-bearing quartz-veinlets (cross-veins or *filons-croiseurs*) occur in the schist in the neighbourhood of the limestone.

Specimens of the various rocks were examined by the author under the

microscope, and he feels no doubt that the cinnabar was deposited simultaneously with the siliceous cement of the breccia. This breccia was undoubtedly mineralized by siliceous waters containing in solution salts of mercury and iron, which found their way through rock-fissures originated by the basaltic eruptions. The yellow and red ochres are alteration-products of the pyrites. In appearance, the breccia recalls the mercury-bearing *frailesca* of Almaden, but its mineralogical composition differentiates it completely from that rock. As in the case of other cinnabar-deposits, that of Kara-Barun will possibly be found to grow richer in depth; a hope which appears to be borne out by the discovery, in a stream-bed close to the exploration-workings, of quartzose fragments containing 45 per cent. of mercury. L. L. B.

COAL AND OTHER MINERALS IN THE TAPASHAN MOUNTAINS, CHINA.

Reise durch das Gebirgsland des Ta-pa-shan; Provinzen Hupeh, Shensi und Szechuan. *By* KARL VOGELSANG. *Petermann's Mittheilungen*, 1904, *vol. l., pages* 11-19 *and* 1 *plate.*

Starting from Ichang, on the Yangtsze river, on May 9th, 1900, the author reached, 9 days later, Panchui-ho, 5 miles north-west of which place is a copper-ore deposit, some 5,000 feet above sea-level. It consists merely of a few thin veins seaming pinkish-yellow quartzites and dark slates, and is of no industrial importance. The same statement holds good of the copper-glance, etc., occurring near Paofeng and Chihluiwan. Yet Chinese prospectors had endeavoured to induce European business-men in Shanghai to purchase concessions for working these useless deposits.

The author then turned southward from Chuhsi, finally reaching the Yangtsze valley again, at Wushan, on June 11th, 1900. At the Luliya pass in Shensi, he observed a thin coal-seam associated with flaggy limestones, probably of Carboniferous age. At Taumushanpen, in Szechuan, the Chinese work thin seams of a highly-sulphureous coal, of inferior quality. It is taken on boats down the river (a left-bank tributary of the Yangtsze), and is mostly used for the evaporation of brine.

It is in the Yenchang valley at Lungchsinmiao, that the brine-spring occurs, from which the salt is obtained for consumption over a wide area. The Government levies a tax proportionate to the amount evaporated from the brine-pans.

The author's general conclusion is that none of the mineral-deposits seen by him on his journey are such as to warrant any attempt at mining operations on a large scale. The coal, especially, can only be of local importance.

It may be observed that the Tapashan mountains include portions of the provinces of Hupeh, Shensi and Szechuan. L. L. B.

THE MINERAL WEALTH OF MANCHURIA AND KOREA.

Constitution géologique et Ressources minérales de la Mandchourie et de la Corée. *By* L. PERVINQUIÈRE. *Revue Scientifique*, 1904, *series* 5, *vol. i., pages* 545-552, *with* 2 *maps in the text.*

Dealing first with Manchuria, the author calls attention to the Coal-measures in the neighbourhood of Mukden, where the seams are in the

usual fashion intercalated among grits and shales. Small coal-basins are fairly numerous in the Liaotung peninsula; as at Wuhoshin, on Society Bay, where several seams, varying from 3 to 13 feet in thickness, of friable coal have been worked; at Talienwan; at Saimaki, on the Korean frontier, where a seam (3 to 5 feet thick) of crumbly bituminous coal occurs. At Pönnhsihu, south-east of Mukden, five or six seams of coal, each 1 foot or 2 feet thick, have been proved: the conditions appear favourable for working, but the strata are much faulted. The mineral is friable, though not specially bituminous, and yields coke of middling quality. None of these coals are suitable for naval purposes or for railway-locomotives, nor would it pay to export them. Good anthracite, however, has been found in Liaohsi.

In Northern Manchuria, the true Coal-measures are not so well developed, but coal-seams of later age (Triassic, Jurassic and Tertiary), crop out at several localities in the Upper Sungari valley, in the neighbourhood of Kirin, in the Argun valley (where a seam of lignite [?], 23 feet thick, occurs among post-Pliocene sands), etc.

Magnetic iron-ore is of common occurrence in the Liaotung peninsula, and copper- and lead-ores have been discovered in Eastern Manchuria. Gold-placers are of widespread occurrence; and rich auriferous quartz-reefs, some of which are worked, occur in the Santaoku district and at Tsitskuho, near Kirin.

In Korea, the true Carboniferous coals are of less importance than those of Tertiary age. The latter occur over large areas in the north of the peninsula. Unfortunately, the high percentage of ash (31) quoted by the author seems to preclude any hope of remunerative working on a large scale. In the Cambrian series of various localities, good hæmatites, copper-ores, and argentiferous galena are found. Auriferous reefs have been noted in several places, as also rich gold-placers (these latter, apparently, are actively worked). The export of gold from Korea was, in 1900, five times as considerable as it was in 1894. L. L. B.

COAL-MEASURE PLANTS IN NORTH AFRICA.

Le Terrain Houiller dans le Nord de l'Afrique. *By* Ed. Bureau. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxviii., pages* 1629-1631.

Already, south of the Algerian province of Constantine, red grits had been reported with carbonaceous deposits containing *Lepidodendron Veltheimianum*, a species characteristic of the lowermost Coal-measures; but recently Lieut. Poirmeur has found in the far south of the province of Oran a specimen of the same *Lepidodendron* and one of *Stigmaria ficoides*: the latter had evidently not been drifted very far from its position of growth before fossilization. These specimens both occur in ferruginous grit. It may be observed that the Carboniferous Limestone, with its characteristic fossils, is of widespread occurrence in the region traversed by Lieut. Poirmeur; and it is shown to be practically contemporaneous with the Carboniferous Limestone of England and of Tournay in Belgium.

The plant-bearing beds seen by Lieut. Poirmeur undoubtedly underlie the marine beds, and if they are in their original position (that is, not overfolded or jammed in) they probably belong to the Dinantian or Culm stage. If this be so, the prospect of striking workable coal-seams is, of course, less hopeful. Yet it is not uncommon to find later and richer

Coal-measures in the near neighbourhood of the Culm, and the industrial importance which would attach to a coal-basin, situated close to the projected great trunk-railway from Oran to Timbuctoo, should encourage further investigation in that part of Africa. L. L. B.

THE COPPER-ORES OF SOUTH-WEST AFRICA.

Kupfererzvorkommen in Südwestafrika. *By* J. Kuntz. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 199-202, *with* 6 *figures in the text.*

In Little Namaqualand, as elsewhere in South Africa, granite or granitic gneiss forms the basement-rock and is overlain by mica- and hornblende-schists, quartzites, etc. Great masses of iron-ore, especially pyrites and magnetite, occur among these, and may be traced by their gossans over long distances. Although exposed along the coastal belt, this Archæan series is inland mantled over by the sandstones, shales and limestones of the Cape formation, which form tabular hills and have a generally-horizontal lie. However, the greater part of Little Namaqualand, and especially the Ookiep-Concordia mining district, lies within the Archæan belt. This is traversed by two fault-systems, trending respectively east-north-eastward and south-eastward, while the crystalline schists strike east and west. The first-named fault-system defines the fissures along which a plagioclase-hornblende-rock was erupted, while, so far as the author can ascertain, the second fault-system shows no trace of infilling with eruptive material.

The copper-ore is an accessory constituent of the plagioclase-hornblende-rock (which may, perhaps, be termed a diorite). It is noticeable that the proportion of hornblende diminishes as that of copper-ore increases, which rather looks as if the latter had metasomatically replaced the former. The ore is mainly bornite and copper-pyrites, and the form and continuance of the ore-body is irregular: it can be followed, for instance, uninterruptedly as a string of nests in a dark dyke amid the pale-grey gneissose country-rock for miles and miles between Springbok, Kupferberg and Carolusberg, while no outcrop is seen between Nababiep and Ookiep, or between the latter locality and Narap. However, it is only at certain spots that the ore occurs in really workable quantity. The rich nests are, in fact, accumulated at points where the two fault-systems cross one another; points, too, which often mark the occurrence of the older iron-bearing schists, as a comparison of dips and strikes shows that the eruptive rocks cut these schists at a sharp angle.

The Ookiep deposit was 1,082 feet in extreme length, its greatest breadth was 230 feet and its greatest depth 330 feet, and it has now been all but worked out. At Narap, the ore-occurrence is of small extent, and is not being worked at present; the Nababiep deposit, however, is apparently enormous. There the diorite forms a great hill, but forewinning had not proceeded far enough, at the time of the author's investigation, for him to say definitely what proportion of the mass consists of copper-ore. At Tweefontein, near Concordia, three "nests" of ore occur, one on the top of the other, at the second line of eruptive dykes north of Ookiep. The mines formerly worked by the Namaqualand Copper Company lie on the first line of eruptives north of that place: they yielded too little copper-ore, but plenty of magnetite. L. L. B.

GOLD-DEPOSITS OF THE KHAKHADIAN MASSIF, FRENCH SUDAN.

Sur les Gîtes aurifères du Massif du Khakhadian (Soudan occidental). *By* H. Arsandaux. *Bulletin de la Société française de Minéralogie*, 1904, *vol. xxvii., pages* 81-86.

This massif rises in the centre of the Bambuk country, which is bounded on the east by Upper Senegal and on the west by the Falemé country: the core consists of steep mountains rising to heights of 2,500 and 2,600 feet, girdled round by lesser hills of the tabular form so common in Western Africa. The region is built up of sedimentary rocks of indeterminate age, but probably of ancient date, amid which are intercalated andesitic tuffs, the whole being traversed by igneous intrusions, and more especially by granite. The last-named has given rise to phenomena of contact-metamorphism, while all the other rocks exhibit the effects of powerful dynamic action which has altered the most basic among them into hornblendic schists. On the site of the old gold-mines of Kenieba, this dynamo-metamorphism appears to have been peculiarly intense, and the hornblende-schists are heavily charged with pyrites, a mineral which occurs also in the microgranites in the immediate neighbourhood of the schists, but there only. Both kinds of rock are auriferous, the gold being derived from the pyrites, and their ultimate decomposition-product is an unctuous clay. Some exploration-work was done among these, half a century ago, by the Senegalese Government. An assay of the microganite recently made by the author showed 85 parts of gold per 1,000,000.

At Yatella, lateritic earths derived from an uralitized ophitic gabbro were at one time washed for gold, but the industry has been long defunct. The most important deposit seems to be that of Sadiola, where the natives work the auriferous laterites: here the proportion of gold in the decomposed rock increases with the depth, until a maximum is reached somewhere about the hydrostatic level of the immediate neighbourhood (a level which is subject to considerable variations, in all tropical countries such as that here described). The gold got from the laterites is but partly capable of amalgamation.

The surface of the Khakhadian massif is covered by a thick crust of reddish-brown conglomerate, consisting of quartzose rock-fragments cemented by a ferruginous clay: this diminishes in thickness as one comes down from the hills to the low country, giving gradually place to a clayey loam. The laterites washed for gold underlie this conglomerate. L. L. B.

GOLD-DEPOSITS OF KATANGA, CONGO FREE STATE.

Les Dépôts aurifères du Katanga. *By* H. Buttgenbach. *Bulletin de la Société Belge de Géologie, de Paléontologie et d'Hydrologie*, 1904, *vol. xviii., Mémoires, pages* 173-186, *with 5 figures in the text.*

Gold occurs in this province in three forms: firstly, in association with silver in the numerous and important copper-ore deposits which the author proposes to describe fully at a future date. Shales, grits and quartzites are in these occurrences so intensely impregnated with carbonates of copper that the ore may be frequently said to constitute the cementing-material of the rocks. The greatest proportion of gold in these hardly exceeds 3 parts per 1,000,000, but the average proportion of silver is 42 parts per 1,000,000: the

precious metals occur, however, in nearly every rock-sample, no matter what the level from which it may have been taken.

Secondly, gold occurs in the alluvia of innumerable streams in the south of Katanga, the most important deposits of the kind being those of Kambove, at which locality is also found one of the richest copper-ore deposits in Katanga. Here are four precipitous gorges, where the torrent-beds are bare in the dry season, exposing a gravel largely made up of pebbles of specular iron-ore and malachite; below this gravel comes a sand almost invariably auriferous, richest in its lower portion: a good deal of native gold, too, is accumulated in the hollows and fissures of the bed-rock. The biggest "nuggets" weigh only from 3 to 6 grammes, the gold being usually in the form of flakes, grains and irregular lamellæ. There is also a gold-placer on the top of the plateau in which the above-mentioned gorges have been cut. The author believes that all this gold is derived from the leaching-out, by atmospheric agencies, of the uppermost portions of the adjacent copper-ore deposits. These uppermost portions are probably but the gossan of deeper-lying veins of magnetite, chalcopyrite and auriferous pyrites. At Funguruma, north-west of Kambove, there is another great cupriferous deposit in grit- and quartzite-hills above the river Dipeta: the detritus brought down from these in the rainy season, and in the rainy season only, is found on washing to contain grains and flakes of native gold; and yet, if the precious metal be sought for in the rocks themselves, traces of it, invisible to the naked eye, can be discovered in the cupriferous bands alone. A similar observation holds good of the fine copper-ore deposit at Likasi, south-south-east of Kambove: this has an average content of 22 per cent. of metallic copper, with 41 parts of silver per 1,000,000 and less than 1 part of gold.

The third form of occurrence, which the author believes to be unique among the auriferous deposits so far known, is exemplified at the Ruwe hill, 9 miles or so west of the Lualaba river. Here the gold is found in undoubted sedimentary strata, which nevertheless bear no resemblance to the Witwatersrand conglomerates: one stratum is made up of a limonite with microscopic quartz-spherules. Five exploration-shafts are being sunk in the plateau-like bed of the hill, which slopes more or less abruptly down to a streamlet known as the Kurumashiwa. The surface is more or less thickly mantled by a sort of drift, formed by the decomposition of the underlying rocks, in which gold is always found in the free state. Below comes a succession of quartzites and grits, with a ferruginous conglomerate at the base. Except the two uppermost quartzites, all these contain gold, silver and platinum, the average proportions (as tested by 24 analyses) being 12·3 parts per 1,000,000 of the first-named metal, 8·3 of the second, and 3·4 of the third. In a banded grit, small, absolutely spherical globules of gold, about $\frac{1}{25}$ inch in diameter, occur. In the basement limonitic conglomerate, some samples have assayed as much as 50 parts of gold per 1,000,000.

The strata of Ruwe are apparently conformable with the slightly cupriferous beds of the Konkolo and Kitambala hills; the former are possibly of Carboniferous age, while the copper-ores generally impregnate rocks provisionally regarded as Silurian. L. L. B.

SUGGESTED ORIGIN OF THE GOLD-BEARING CONGLOMERATES OF THE TRANSVAAL.

Expériences sur la Formation de certains Conglomérats : Origine des Poudingues aurifères du Transvaal. *By* P. FOURMARIER. *Annales de la Société Géologique de Belgique*, 1904, *vol. xxx., Bulletin, pages* 124-128.

With the view of determining the origin of the cementing-material of certain conglomerates, such as the Palæozoic ferruginous puddingstone of the neighbourhood of Spa, the author has been for some time engaged in a series of experiments. These have led him to enunciate a new theory in regard to the genesis of the gold-bearing conglomerates of the Witwatersrand. According to this hypothesis, the rolled pebbles of quartz and quartzite are derived from the erosion of rocks traversed by veins of auriferous and ferruginous quartz. The association of the gold with pyrites is invariable: whence it is concluded that the rolled pebbles themselves contain gold and pyrites. Now, just as in the author's experiments, when lumps of ferric sulphate, contained within spheres of plastic clay, laid amid a bed of sand, gradually dissolved away, and iron-compounds were deposited in the sand around the spheres of clay—so the gold and the iron in the Witwatersrand pebbles were dissolved away particle by particle, and were reprecipitated outside the pebbles, forming the cementing-material, from which, by metamorphism, was derived the crystallized pyrites.

The author points out that the foregoing hypothesis fits in exactly with all the characteristic features of the Transvaal deposits, as described by Prof. L. de Launay; whereas no other theory so far suggested does fit in exactly with them. L. L. B.

NEW DIAMOND-DEPOSITS IN THE TRANSVAAL.

Über einige neue Diamantlagerstätten Transvaals. *By* A. L. HALL. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 193-199, *with* 3 *figures in the text.*

The six diamond-mines opened up in the colony at the time of writing, are situated about 22 miles east-north-east of Pretoria in a bare, hilly, quartzite-country, cut off to the south by a valley eroded in softer shaly rocks. The diamantiferous deposits occur among the Magaliesberg quartzites and associated eruptives of the Pretoria series, a subdivision of the Cape system, which is unconformably overlain by the dark-red grits and conglomerates of the Waterberg Sandstone series. The eruptive rocks consist chiefly of sills of so-called "diabase" striking parallel with the Pretoria beds; with this diabase an acidic rock (provisionally termed "felsite") is associated, especially where "blue ground" occurs. The general dip of the beds is 19 degrees north-eastward, and the strike is south-east and north-west.

The hard "blue ground" is found in the form of pipes, and in a decomposed condition as "yellow ground"; and diamantiferous deposits also occur as alluvial placers. At the Premier mine, "yellow ground," at a depth of 45 feet from the surface, passes into hard "blue ground." A boring put down in the neighbourhood of the south-western boundary of the concession passed through "blue ground" down to a depth of 1,000 feet, but other two bore-holes struck barren ground after depths of only 190 and 260 feet respectively. The area of this concession alone exceeds that of all the De Beers claims at Kimberley put together, and the possible output of the "yellow ground,"

not to speak of the "blue ground," is estimated at more than £10,000,000 sterling. The breccia-like "blue ground" resembles the "hard bank" of Kimberley: it undoubtedly will yield diamonds, but whether so many in proportion as the "yellow ground" remains to be seen.

On the whole, up to March, 1904, in an area of 38 square miles of the Pretoria district, four "pipes" of diamantiferous "blue ground" had been discovered, the biggest being 2,950 feet and the smallest 240 feet in diameter. At least three diamond-bearing placers have been proved in the same district. The hard "blue ground" is, in all probability, a highly-serpentinized peridotite, at one time rich in olivine: where the slates, quartzites, etc., have been burst through, the "blue ground" takes on all the characters of a breccia.

The output of the mines has increased enormously during the past year or so, and there seems every reason to believe that the diamond-mining industry of the Transvaal has a brilliant future before it. The author supplies detailed statistics from July, 1902, up to March, 1904. L. L. B.

METALLIFEROUS AND OTHER DEPOSITS IN THE ARGENTINE REPUBLIC.

Comunicaciones mineras y mineralógicas. *By* Guillermo Bodenbender. *Boletin de la Academia Nacional de Ciencias de Córdoba*, 1903, *vol. xvii., pages* 359-381, *with* 1 *figure in the text.*

The author first of all describes the onyx-marble of the provinces of San Luis and Mendoza, the thickest bed of which measures about 5 feet. The prevailing colour is pale-green, often handsomely streaked with yellow, pink and grey. The onyx contains a good deal of carbonate of iron, and its specific gravity ranges between 2·7 and 2·9. It no doubt originated in the thermal waters, the upflow of which followed on the andesitic and basaltic eruptions of late Tertiary or early Quaternary time. The onyx of the Sierra de San Luis has been worked for many years, and finds a ready sale: but the author believes that unworked deposits still await the explorer in that region. The onyx of San Rafael, on the Arroyo Salado, is of equally-fine quality, and the transportation-facilities which the railway now being built to Mendoza will afford, will doubtless permit of the mineral being worked with profit.

The best-known auriferous veins in the province of Jujuy are those of La Rinconada, a small village situated at a height of about 13,000 feet above sea-level, in a ravine which cuts the eastern face of the Sierra de Cabalonga. Facilities of transport are promising, the timber-supply is good, and water can be got in abundance from the lake of Pozuelos. The gold-quartz reefs occur among black slates and greywackés of Silurian or Devonian age, generally striking north and south and pitching almost perpendicularly. The thickness varies from 1 to 80 inches, though in the Blanca mine a group of reefs attains a combined thickness of 50 feet. A heading has been driven below ground, to a depth of some 52 feet and for a length of 525 feet, cutting at least seven of the reefs: those in the black slates are, generally speaking, richer than those in the greywackés. The inflow of water constitutes a great difficulty, even at so shallow a depth as 33 feet, and the conditions do not permit of draining it off through shafts. Placers also are worked in this locality, yielding in the *batea* 3 parts of gold per 1,000,000.

The author claims to have found "native lead" in the alluvium of these placers, in the form of small nodules, grains, flakes, etc., covered by an

earthy-grey pellicule of carbonate of lead. He also describes and gives analyses of the nodules of ulexite (boro-natro-calcite), about the size of a man's fist, which occur to a depth of about 5 feet in the Salinas Grandes of Jujuy. The formation of these nodules, sufficiently important from the industrial point of view, is going on at the present day, owing to the continuous evaporation of the saline waters containing borates in solution. From a locality to the west of Tinogasta, in the province of Catamarca, selenides, sulphides and carbonates of copper have obtained, and it seems probable that the ores there will prove to be of industrial importance.

Cassiterite has lately been recorded from the Cerro de las Minas in the province of Rioja, in ferruginous quartz-veins in a country-rock of gneiss, greisen and granulite, and associated with arsenical pyrites. Water-supply for mining purposes is readily available in the district. The nearest railway-station is Chumbicha, 14 leagues away, on the Recreo-Catamarca line.

New occurrences of metalliferous ores in various other localities in the Argentine Republic are described, but we are not told whether they are in quantity sufficient to repay working. L. L. B.

BRAZILIAN TITANIUM-MAGNETITES.

Über die Mikrostruktur einiger brasilianischer Titanmagneteisensteine. *By* E. Hussak. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie,* 1904, *vol. i., pages* 94-113, *with* 2 *figures in the text and* 1 *plate.*

The author made an elaborate chemical and microscopic investigation of magnetites from 15 different localities in Brazil. As regards their origin, these ores are divisible into two distinct groups: (1) magnetites derived from acidic eruptives (such as granites and gneissose granites), and generally occurring only as thin reefs or narrow veins; and (2) magnetites derived from basic eruptives (pyroxenites, etc.), especially noticeable in the nepheline-syenite areas, and occurring in great masses, the outcome probably of magmatic differentiation.

The author summarizes the results of the investigation as follows:—A titanium-mineral analogous to ilmenite, corresponding to the formula $(FeMgMn)O.TiO_2$, occurs intergrown with the magnetite, generally following the octahedral faces of the latter, sometimes accumulated irregularly and sometimes in the form of denticulated granules. The last-named prove to be built up of lamellar portions, which are unequally attackable by hydrochloric acid. In addition to these titanium-lamellæ, the residue insoluble in acids contains predominantly a green iron-spinel and a whole series of other accessory minerals, which respectively characterize the derivation of the iron-ore either from an acid or from a basic eruptive. Thus, in titaniferous magnetites of granitic origin, zircon, corundum and monazite appear; while in those of basic origin, perowskite (frequent), baddeleyite, secondary anatase, and a pyrochlore-mineral are found. The titanium-content of titaniferous magnetites, and probably of many ilmenites, is assignable to the usually very regular intergrowth of the aforesaid titanium-lamellæ with the magnetic iron-ore. L. L. B.

ROCK-SALT DEPOSITS, ETC., IN THE REPUBLIC OF COLOMBIA.

Minerales alcalinos y terrosos de Colombia. *By* R. Lleras Codazzi. *Trabajos de la Oficina de Historia Natural: Seccion de Mineralogia y de Geologia*, 1904, *pages* 1-27.

The richest salt-deposit in Colombia, and one of the most important in the whole world, is that of Zipaquirá. Here the mass of rock-salt is stated to be such as to require centuries of working to exhaust it. The mineral is of high quality, being on the whole exceptionally pure, and is worked by means of horizontal galleries. Of equally good quality is the salt of Nemocón, a short distance away, but the methods of working are very defective. Rock-salt deposits are also worked at Sesquilé and Upín. In all the localities mentioned, the associated strata are sandstones, limestones and coal, striking south-westward and north-eastward, and exhibiting a fairly-steep dip (45 to 50 degrees).

Brine-springs are tapped at a great number of localities, and there are vast efflorescent salt-deposits on the Atlantic coast of the Republic.

Deposits of potassium nitrate have been worked from time immemorial in the south of the department of Santander.

Gypsum is one of the minerals most commonly met with in Colombia, and anhydrite occurs in considerable masses at Zipaquirá.

Marble of commercial value is recorded at several localities, especially in the department of Santander, where there is a fine-grained shell-marble, which admits of a high polish, and is comparable with the famous *lumachello* of Italy.

The occurrence of wavellite (hydrated phosphate of alumina) may be mentioned here, as its fine green coloration misled ignorant prospectors, in some localities, into pegging out claims for emerald-mining.

Monazite is found in the sands of the Rio Chico, in the department of Antioquía. L. L. B.

PETROLEUM-DEPOSITS OF PICHUCALCO, CHIAPAS, MEXICO.

Criaderos de Petroleo de Pichucalco. *By* Maximino Alcala. *Memorias de la Sociedad Cientifica "Antonio Alzate,"* 1903, *vol. xiii., pages* 311-326 *and* 1 *plate.*

The Guadalupe estate, where the petroleum is found, lies 7½ miles south-west of Pichucalco, the chief town of the department of that name, in the state of Chiapas, some 660 feet above sea-level. There is river-communication with San Juan Bautista (the capital of the state of Tabasco) some 50 miles away to the north-east, but the road leading to the same place is only practicable in the dry season, and even then simply for packhorses and mules, not for wheeled traffic.

The petroleum wells out at the surface, on the northern flank of the Cerros del Diablo, one of the most easterly spurs of the great Sierra Madre: the oil-bearing beds strike generally north-east and south-west, dipping 15 degrees north-westward. At the San José oil-well, on the left bank of the Chapopote river, the petroleum is seen to come from a loosely-compacted conglomeration of clayey gravel and sand, intercalated among blue clays. The oil impregnates this bed over a thickness of 7 feet, the impregnation being more pronounced in the lower half. There are indications of another but less important petroliferous band at a higher geological horizon. The

actual extent of the principal deposit has not yet been determined, but it has been traced at various points in the area situated between the Chapopote and Guineo rivers. The crude oil does not contain paraffin or the light benzines, but it is used locally for illuminating purposes. It could be more profitably utilized as fuel, just as it comes from the well. The author believes that when deep wells are sunk in the district, deeper-lying reservoirs, containing oil which is not bereft of the above-mentioned constituents, will be tapped. He points out in some detail the striking analogy between the geological (tectonic and stratigraphical) conditions of the district and those of the oil-fields of North America and Baku, the one difference being the clayey nature of the oil-bearing bed already struck near Pichucalco. Naturally, sandy beds are better absorbers of petroleum, and such beds may be found deeper down, possibly much nearer the surface than is the case, say, in Pennsylvania.

A light railway is being built to Cosoayapa; timber and water-supplies are abundant; provisions are cheap, but skilled mining labour is scarce in the immediate neighbourhood. Wages average from 2s. 6d. to 3s. ($1\frac{1}{4}$ to $1\frac{1}{2}$ Mexican dollars) *per diem*. L. L. B.

ORIGIN OF THE PETROLEUM OF ARAGÓN, MEXICO.

Estudio de la Teoría química propuesta por el Sr. D. Andrés Almaraz para explicar la Formación del Petróleo de Aragón. *By* JUAN D. VILLARELLO. *Parergones del Instituto geológico de Mexico*, 1904, *vol. i., pages* 95-111.

This paper is an elaborate refutation, on chemical grounds, of an official report published in 1903 by Mr. Andrés Almaraz, on the oil and natural gas found in a well at Aragón in the Federal District of Mexico. That author stated that the petroleum consisted of hydrocarbons, ranging from decane ($C_{10}H_{22}$) to octodecane ($C_{18}H_{38}$), and contained no unsaturated hydrocarbons; further, that the well-water yielded abundance of carbon dioxide and variable quantities of ferrous orthocarbonate. He reviewed several of the current theories as to the origin of petroleum, concluded that none of them were applicable to the Aragón well, and propounded the following chemical theory: The existence of an unstable salt of iron being proved in this well, could not that salt act as a reducing agent on the water and the carbon dioxide, the result of the reaction being the combination of the hydrogen of the water with the carbon of the carbon dioxide? He terms this an "exothermic" reaction, which the present author shows it is not, but distinctly "endothermic." Now, in order to bring about an endothermic combination, the intervention of some extraneous source of energy is indispensable. The idea, therefore, that the above-mentioned reaction is going on and will continue indefinitely, of itself, in the Aragón well, is shown to be baseless, the proof that such a reaction takes place at all in nature being still to seek. Thus far, then, there is no evidence of the existence of a petroleum-deposit of any great importance, still less of an "inexhaustible" one, in the neighbourhood of Aragón. It is impossible to give in a short abstract an adequate idea of the closely-reasoned arguments and long series of chemical equations, by means of which the author establishes his main contention. L. L. B.

THE COAL-FIELDS OF LAS ESPERANZAS, COAHUILA, MEXICO.

The Coal-fields of Las Esperanzas, Coahuila, Mexico. By EDWIN LUDLOW. *Transactions of the American Institute of Mining Engineers*, 1901, *vol. xxxii., pages* 140-156, *with* 6 *figures in the text.*

The Las Esperanzas coal-field was discovered in the spring of 1899. It is situated in the state of Coahuila, about 85 miles south-west of Eagle Pass, Texas. The coal is found in the Upper Cretaceous, and corresponds with the Laramie measures of the United States.

The area of the basin at the south-eastern end, where the seam is of good thickness and not too steep for economical operations, is about 6,000 acres. Work was commenced in November, 1899, with the view of developing the field for an output of 5,000 tons per day. In the course of 2 years, the necessary development-work has been done and machinery erected for obtaining this output, but great difficulty has been experienced in obtaining suitable labour.

The coal is a soft bituminous coking coal, containing 9·8 per cent. of ash. The seam is from 8 to 9 feet thick, and contains various bands of shale, aggregating 14 to 17 inches in thickness.

A coking-plant, consisting of 224 ovens of the bee-hive type, has been erected, so as to supply coke to the smelters of Northern Mexico. The present output from the mines is 1,200 tons per day. R. W. D.

THE IRON-ORES OF IRON MOUNTAIN, DURANGO, MEXICO.

The Iron Mountain, and the Plant of the Mexican National Iron and Steel Company, Durango, Mexico. By T. F. WITHERBEE. *Transactions of the American Institute of Mining Engineers*, 1901, *vol. xxxii., pages* 156-163, *with* 1 *figure in the text.*

The Iron mountain, situated $\frac{3}{4}$ mile north-east of the limits of the city of Durango, rises abruptly from a level plain. The mass of solid ore, about $1\frac{1}{3}$ miles long, $\frac{1}{3}$ mile wide and from 200 to 400 feet high, is estimated to amount to 360,000,000 tons of iron-ore containing from 60 to 65 per cent. of iron. A blast-furnace has been erected in close proximity to the mountain. The fuel used is principally charcoal, but coal is occasionally mixed with the charcoal. The rolling-mill has 5 double puddling-furnaces. The iron produced is of good quality. All the labour, skilled and unskilled, is Mexican throughout, excepting the heads of departments. The iron-ore is also used as a flux by Mexican lead-smelters. R. W. D.

THE ORE-DEPOSITS OF THE SIERRA MOJADA, COAHUILA, MEXICO.

The Sierra Mojada, Coahuila, Mexico, and its Ore-deposits. By JAMES W. MALCOLMSON. *Transactions of the American Institute of Mining Engineers*, 1901, *vol. xxxii., pages* 100-139, *with* 14 *figures in the text and* 1 *plate.*

The Mojada mines, situated in the midst of an extensive desert, were discovered in 1878. At first, they were worked in a very primitive way, and the ore was carted 75 miles to the railroad. The average grade of ore now being worked is:—10 ounces of silver per ton and 15 per cent. of lead. The production in 1900 was 191,000 tons.

The mountains forming the Sierra Mojada are composed entirely of limestone. The ore-deposits may be divided into three main groups:—(1) The contact-deposits; (2) the lime-impregnations; and (3) the lead-carbonate ores in the limestone. Detailed descriptions are given of the deposits.

In the early workings very little timber was used, and the miners contented themselves with following up the rich ore-streaks. The excavations are now timbered with square sets, and by the introduction of modern methods it is found profitable to re-work the old and but partly exhausted stopes throughout their entire extent. Labour is fairly abundant, and costs 3s. (1½ Mexican dollars) per day. The climate is healthy and pleasant.

R. W. D.

GENESIS OF THE MERCURY-DEPOSITS OF PALOMAS AND HUITZUCO, DURANGO, MEXICO.

Genesis de los Yacimientos mercuriales de Palomas y Huitzuco, en los Estados de Durango y Guerrero de la Republica Mexicana. *By* JUAN D. VILLARELLO. *Memorias de la Sociedad científica "Antonio Alzate,"* 1903, *vol. xix., pages* 95-136.

The author shows, in the first place, how thermal waters containing in solution carbonic acid, sulphide, sulphate, thiosulphate and carbonate of soda, are perfectly capable of dissolving all the minerals usually found associated together in mercury-deposits; and, after devoting some pages to the purely-chemical side of the question, he proceeds to give a brief description of the Palomas deposit in the state of Durango. It occurs at the zone of contact between rhyolites and basalts, some 50 miles west of the capital city of the state. Contact-metamorphism has partly altered the rhyolites into a white clay, raddled in places by iron peroxide. Within the clay occur irregular veins of amorphous silica, with which in places cinnabar is closely intermixed: occasionally the whole vein is coloured red by the ore, and the neighbouring clay, sometimes for a breadth of about 3 feet on each side of the vein, is impregnated with cinnabar. Bituminous substances are found in various parts of the deposit, and also a small quantity of native mercury. The horizontal extent of the ore-body is small, say barely 1,000 feet, and in depth it does not usually go down beyond 20 to 25 feet. The richness of the crude ore is variable, from 0·05 to 5 per cent. of metallic mercury being the usual assay, and very few specimens assay to as much as 40 per cent. of the metal. The ore-body is bounded both on the east and west by very slightly-altered rhyolites; it is manifestly later in date than the eruption of these, and is consequently of Tertiary age. It was evidently formed by thermal waters which deposited, in fissures opened up in the rocks, some of the metalliferous material that they held in solution. It cannot possibly have been formed by sublimation.

The Huitzuco deposit lies about two-thirds of a mile south of the locality of that name, and 17 or 18 miles east of Iguala. It occurs in the Middle Cretaceous limestones, which are bounded on the west by the andesitic eruptives of Noxtepec and Taxco. The irregular cavities (fissures enlarged by the action of thermal waters) in the limestone are infilled with cinnabar, livingstonite or sulphantimonite of mercury, pyrites, sulphur, gypsum and occasionally metacinnabarite or black sulphide of mercury, also ferruginous clay impregnated with cinnabar. Both the ore-body and the contiguous country-rock are impregnated with organic substances. At various levels,

but more especially at the depth of 590 feet, emanations of sulphuretted hydrogen are observed. Nearer the outcrop, the sulphantimonite of mercury and the pyrites appear to have undergone oxidation. The whole deposit forms a series of pockets occupying a horizontal breadth of 260 feet or so, and extending down to a depth of at least 820 feet (the lowest level of the La Cruz mine in 1898). There is a gossan of red clay impregnated with cinnabar, seamed with veinlets of calcite. The distribution of the minerals previously enumerated is very irregular throughout the deposit. The amount of metallic mercury and antimony obtained from the ores appears to diminish as the workings are pushed deeper downward, varying from 5 to 10 per cent. down to ¾ and 1 per cent. of mercury, and from 40 per cent. down to 10 per cent. of antimony. It is evident that the Huitzuco deposit, like that of Palomas, is the outcome of the percolation of thermal waters, and in this case too, the sublimation-theory must be dismissed as impossible. The deposition is probably connected with the volcanic phenomena of Tertiary times, whereof the andesites of Noxtepec and Taxco are the silent witnesses. The *dictum* of Prof. Fuchs and Prof. De Launay may be re-called, in regard to mercury-deposits all over the world, that they are, geologically speaking, of recent formation as a rule.

The author pictures, in considerable detail, the connection between the phenomena of moribund vulcanicity and the various chemical processes and reactions whereby the mercury and other associated ores were finally precipitated in their present *locus*. L. L. B.

THE ORE-DEPOSITS OF ANGANGUEO, MICHOACÁN, MEXICO.

El Mineral de Angangueo, Michoacán. By Ezequiel Ordóñez. *Parergones del Instituto geológico de Mexico*, 1904, *vol. i., pages* 59-74, *with* 4 *figures in the text and* 1 *plate.*

The mining district described in this memoir is situated on the western spurs of an extensive mountain-range on the borders of the states of Mexico and Michoacán. The massif is built up of an enormous thickness of more or less metamorphosed slates and limestones, presumably of Cretaceous age; with these are associated two groups of eruptive rocks:—(1) Miocene andesitic "greenstones," and (2) basalts, the outpourings of the volcanoes which have been active in the region from Pliocene down to recent times. Both the Cretaceous slates and the Miocene andesites are traversed by metalliferous veins of varying composition and structure. Two localities are the scene of great industrial activity: El Oro, where gold-bearing quartz-reefs occur in the slates, buried up at some points by the later basalt-flows; and Tlalpujahua, where thick silver-bearing veins traverse similar slates and highly-metamorphosed slaty "greenstones." Third in order of importance, and probably of antiquity, comes Angangueo, with its comparatively-thin metalliferous veins seaming the andesitic eruptive rocks. These veins are generally poor in silver, and the chief ores are sulphides of iron, lead and zinc. Four main veins are recognized, striking between 10 and 40 degrees north-east, and dipping variously east and west: they are mutually connected by numerous branch-veins, which do not strike off from the main leaders at angles much exceeding 30 degrees. There is every reason to infer that they all belong to one system of fissures, originated by a single tectonic "spasm." The gangue is essentially a milky-white quartz, the transparent form of the mineral

occurring but seldom. Manganese occurs in the shape of pink carbonates and silicates, and the commonest ore is a very pale pyrites, sometimes mixed with marcasite. Blende is abundant, usually black, and its increasing abundance is generally an indicator of the impoverishment of the vein: on the other hand, the darkest blende always yields a larger percentage of silver. Galena occurs in big masses, but has diminished to such an extent in the veins most recently worked, that not enough is got to keep the smelters going. A mass of pure galena is being worked on the San Cristobal vein, and such masses usually yield an average of 0·2 per cent. of silver. The three sulphides which have been described were evidently deposited contemporaneously in the fissures, as they are intermixed in the most irregular manner. The topographical situation of Agangueo and the abundance of water in the mines have prevented the workings from being carried to any great depth so far, but the modern miner is now equipped with more powerful weapons for fighting these difficulties. The average silver-content of the ores varies from 0·09 to 0·1 per cent., and the output of ore amounts to about 500 tons weekly. Some 1,800 persons are employed in and about the mines.

L. L. B.

ASBESTIFORM MINERAL FROM MICHOACÁN, MEXICO.

Estudio de una Muestra de Mineral asbestiforme procedente del Rancho del Ahuacatillo, Distrito de Zinapécuaro, Michoacán. By Juan D. Villarello. *Parergones del Instituto geológico de Mexico*, 1904, *vol. i., pages* 133-149.

This yellowish-white mineral, described as being of foliated texture, the folia being flexible but not elastic, resembles in its general aspect "fossil cork" or "mountain-leather." Its hardness is 2·5 and its specific gravity 2·18; and analysis shows it to be a hydrosilicate of alumina with carbonate of lime, the chemical composition being expressed by the formula $H_{10}Al_2Si_3O_{14} + CaCO_3$. It belongs to the kaolin-group and approximates to montmorillonite. Despite its outward resemblance to many asbestiform minerals, it differs widely from them in its composition and in its properties. The industrial uses for which it could be made available do not cover a very wide field: it might be used for boiler-covering, or it might be manufactured into inferior firebricks, but this would be an expensive process. The sample analysed was obtained on the Ahuacatillo Ranch, in the district of Zinapécuaro, state of Michoacán.

L. L. B.

THE MINING DISTRICT OF PACHUCA, MEXICO.

The Mining District of Pachuca, Mexico. By Ezequiel Ordóñez. *Transactions of the American Institute of Mining Engineers*, 1901, *vol. xxxii., pages* 224-241.

The mining district of Pachuca was discovered in 1522, and mining operations have been carried on there since that date with varying energy and success. It is estimated that Pachuca has produced more than 8,000,000 pounds of silver. The Pachuca range is formed of volcanic Tertiary rocks, and the crest of the mountains runs approximately north-west and south-east. One system of fissures, running more or less east and west, comprizes the principal veins of the Pachuca district. In these, lode-quartz forms the principal part of the mass. The width seldom exceeds 22 feet, and

some of the lodes extend for a distance of 10 miles. The rich ore occurs in *bonanzas* of varying shape and size. One of the largest of these, at San Rafael, is elliptical in form, the greatest axis being more than 3,000 feet long and the smaller 1,200 feet, with an average thickness of 8 feet; this *bonanza* has produced nearly £2,800,000 during a period of 10 years. In Pachuca, the impoverishment of the veins at great depths is admitted to be a fact, but the author believes that by carrying on investigations at a greater depth, new *bonanzas* might be discovered. R. W. D.

THE VANADIUM-ORE OF CHARCAS, MEXICO.

El Vanadio de Charcas. *By* Gustavo de J. Caballero. *Memorias de la Sociedad científica "Antonio Alzate,"* 1903, *vol. xx., pages* 87-98.

The ore occurs in the form of waxen-yellow crystalline needles of vanadate of lead, set closely parallel one to the other in fairly-continuous streaks, in a mine hitherto worked for silver-ores. As a matter of fact, the vanadate may be regarded as an incrustation on the walls of the argentiferous reef. The mineral has a hardness of 3·5 in the accepted scale, and a specific gravity varying between 6·20 and 6·25. Analysis shows it to contain 54 per cent. of lead, 13·3 per cent. of vanadium, 4·2 per cent. of zinc, 4·1 per cent. of copper, 2 per cent. of phosphorus, and 4·8 per cent. of arsenic. Sesquioxide of manganese occurs in small quantities as an impurity, evidently mixed, but not combined with, the other constituents. The chemical composition is expressed by the formula $PAs(VO_4)4Pb_4CuZn + H_2O$, and the author defines the mineral as true ramirite, a variety of descloizite. The mineral is regularly worked and exported to France; thus, between January 1st and August 28th, 1903, about 3½ tons of ramirite were exported from Charcas (in the state of San Luís Potosí), with an average content of 10½ per cent. of vanadium.

L. L. B.

MINERAL RESOURCES OF CAJATAMBO, PERU.

La Minería en Cajatambo. *By* Mariano Lezanibar. *Boletin del Ministerio de Fomento,* 1903, *No.* 9, *pages* 14-18.

The argentiferous mines of Chanca and Anamaray were worked with successful results until quite lately; indeed the reason of their recent abandonment has not been made known, to the Peruvian Government at any rate. Smelters remain actively employed in the province, and new lixiviation-works are in course of erection on the Ututo Estate. The fall in the price of silver and difficulties of transportation appear to be the chief obstacles to the development of the mineral industry in the province of Cajatambo. On the other hand, the cheapness of labour, the abundance of fuel, the mildness of the climate, and the wealth of its minerals in lead, copper and silver give promise of a brilliant future, so soon as the above-mentioned obstacles are surmounted.

In addition to the ores just enumerated, wolframite is largely worked in the district of Chiquian; graphite occurs abundantly at Auquimarca and Andajes (localities noted also for iron-ores, more especially hæmatite); gypsum is found in abundance at Churin, and good fire-clays at Pumahuaín and Ututo. Silver-bearing antimony-ores are reported from the village of Roca, district of Ticllos, and gold-bearing veins occur at Ambar, 14 leagues from the Pacific seaport of Huacho.

Finally, it is asserted that the coal-bearing belt of Oyón (a locality distant 30 leagues from the same port) is one of the most considerable of the kind in the world. Over an area measuring 48 miles from south-east to north-west, and 34 miles from north-east to south-west, range three continuous mighty seams of coal, each varying in thickness from 65 to 165 feet. They are intercalated among Jurassic sandstones, and are well exposed in the five great ravines which traverse the coal-field and converge on Oyón. At some localities, the seams are divided by so thin a parting of sandstone as to form one huge mass of coal, 2,000 feet thick and more. (In reality, we are dealing here with seams repeated over and over again by tightly-packed folding.) The coal is of good quality, and varies in character from hard anthracite to a soft bituminous mineral; it never yields more than 5 to 7 per cent. of ash. The author recommends his Government to undertake a scientific investigation of a coal-field which is evidently destined to prove a source of great wealth to Peru. L. L. B.

MINING IN THE PROVINCE OF DOS DE MAYO, PERU.

(1) *La Minería en la Provincia Dos de Mayo.* *By* Estenio J. Pinzás. *Boletín del Ministerio de Fomento*, 1903, *No.* 11, *pages* 32-44.

This province occupies a high plateau flanked by the Western and Central Cordilleras, and watered by the Río Marañon and its tributaries. In the Cordilleras and in the spurs which run down from them, walling in many a deep valley, are countless metalliferous reefs and veins, belonging in part to a north-and-south group and in part to an east-and-west one, and therefore crossing each other at right angles. Between the Western Cordillera and the Marañon basin occur outcrops of anthracite, bituminous coal, and petroleum-bearing limestone in exceptional abundance and of excellent quality. The seams strike north-west and south-east, and dip south-westward, coinciding as to their strike with the silver-bearing metalliferous veins.

The author devotes the major part of his memoir to the western portion of the region, because it lies nearer to Huallanca, and has been explored in greater detail. Mines have been worked here for pyrites, blende, galena, cinnabar and richly-argentiferous grey copper-ore. The great Lluiyag reef, of an average thickness of 6½ feet, has at the outcrop an infilling of iron-pyrites, blende and galena: it is, however but little worked, and one gathers that the conditions do not permit of shaft-sinking. West of this, in a central belt bounded by great fault-fissures, range:—(1) The Mercedes reef, 1 to 6½ feet thick, yielding iron- and copper-pyrites, and richly argentiferous tetrahedrite, with an appreciable proportion of gold; (2) the Pozo Rico reef, very similar to the former in thickness and in mineralization; and (3) the gigantic Pucacyacu or Huanzalá reef, attaining at some points a thickness of 131 feet, with a visible extension of 75 miles, and having parallel to it a sort of accessory reef about 6½ feet thick: the infilling consists mainly of sulphidic ores of copper, zinc and lead. Five-hundred mining concessions have been taken out in this central belt, but a large area remains still untouched. West of the central belt again, and coincident in fact with the chain of the Western Cordillera, is a strip some 80 miles long and 1¼ miles broad, where the ores (although rich enough in copper) are too poor in silver to repay the cost of export. It may be observed that, for many years, the mines in that part of Peru have been worked, simply with the view of getting ores rich enough in silver to justify their export in the crude state to

Great Britain and Germany. East of the central belt before-mentioned is a strip about 4 miles wide, characterized by numerous seams of anthracite, varying in thickness from 4 to 10 feet. In the very midst of the strip is situated the town of Huallanca, and the anthracite crops out in the surrounding hills. The mineral is of good quality, and is used both for industrial and for household purposes. Farther eastward, the metamorphic quartzites are folded into synclines, and anthracite is replaced by a non-coking coal, as far as Huacoto. Here the quartzites disappear, and are replaced by limestones, folded into anticlines and synclines, and extending over a distance of nearly 100 miles. Among them occur petroleum-bearing beds, and seams of a bituminous, highly-tumescent coal, which yields a very light porous coke. Thick seams of good bituminous coal have been recorded in other districts, as, for instance, in the Magapata range, where no less than seven seams occur, varying in thickness from 2 to 6½ feet. Gold-placers are worked in various localities, and the author points out that the following deposits have never yet been worked at all: the titaniferous iron-ore of Yanas; the stibine of Llama-ragra and Ventanilla; the magnetite of Chuspi; the native copper of Huamash; and the native sulphur and elaterite (elastic bitumen) of Chonta; etc.

On the whole, the mineral industry of the province bears at present no sort of proportion to its enormous mineral resources. The needful capital, opines the author, can hardly be attracted thither until a Government commission of engineers has instituted a thorough and impartial enquiry into the facts, noting carefully whatever appears to offer a favourable opening to the capitalist.

(2) *Informe preliminar sobre la Veta Pozo Rico, en la Provincia Dos de Mayo.* By M. A. Denegri. *Boletin del Ministerio de Fomento*, 1903, *No.* 7, *pages* 80-91, *with* 1 *figure in the text and* 1 *plate.*

The mines which work this reef are situated in the mountains west of the village of Huallanca (11,625 feet above sea-level), in the province of Dos de Mayo, department of Huánuco. The district of Huallanca has been far-famed for its mineral wealth for well-nigh 130 years, and abandoned mines and broken-down smelting-works are seen on every hand. That they are not now in active operation is largely due to the absence of roads, whereby the ores could be transported to the Pacific seaboard.

On the Pozo Rico reef, however, seven concessions are being worked: it really consists of two parallel bands, with a barren parting of 330 feet, interbedded, to all appearance conformably, with quartzites and greywackés. Thin bands of black shale are in direct contact with the reef, and their presence should rather tend to facilitate the working thereof. The reef thins out and thickens again with such extraordinary irregularity, that the author does not venture to estimate its average capacity. Both parts of the reef consist of a quartzose gangue impregnated with silver-bearing sulph-antimonite of copper (tetrahedrite) and iron-pyrites. That portion of the ore which is sent away for export, represents the richest tenth of the whole output, and contains from 15 to 20 per cent. of silver and 14 to 17 per cent. of copper. The ore worked upon the spot, on the other hand, contains only 0·15 to 0·25 per cent. of silver and 1½ to 2 of copper.

So far the workings have only touched the surface of the deposit, and the author, in contradistinction to the popular opinion, holds that it continues in depth. He is incredulous, however, of its real conformity with the country-rock, and believes that lower down the reef cuts across the bedding.

The smelting-works of La Florida treat locally 70 tons of ore per month. Outcrops of coal (anthracite, bituminous gas-coals and coking coals) are abundant in the neighbourhood, but no one troubles to work them at present. The moment the cart-road, now under construction, is completed, a good trade can and will be done with Supe harbour on the Pacific. Labour is dear and unsatisfactory, and the author speaks severely of the indiscipline and immorality of the native *peones*. Timber and building materials, provisions and good pasturage for cattle are easily available. Salt, sulphur and chemicals are brought over the mountains by pack-mules from the Pacific seaboard, and the price of such articles is consequently much enhanced. The author advocates the syndicating of the mines at present at work, so as to enable operations to be conducted more economically and on a larger scale. L. L. B.

MINERAL RESOURCES OF THE PROVINCE OF HUÁNUCO, PERU.

Recursos minerales de la Provincia de Huánuco. *By* Nicanor G. Ochoa. *Boletín del Cuerpo de Ingenieros de Minas del Perú*, 1904, *No.* 9, *pages* 1-43 *and* 6 *plates.*

In the district of Huánuco itself are reefs of ferruginous gold-quartz, in a country-rock of mica-schist, partly worked in former days, but apparently of no great industrial interest now. The district of Ambo seems to be rich in metalliferous ores, and in thermal springs yielding medicinal waters. The ores are silver (with varying proportions of gold), iron- and copper-pyrites, galena, etc. Near Chauchac are outcrops of anthracite, which is, however, so full of impurities that it cannot give rise to any hope of working it at a profit. Reasons are also given for the author's opinion that it would not be practicable to work the gold-placers of the El Valle district on a large scale (by hydraulicking): the occurrence of gold is very widespread in the alluvial deposits of this district. The Rondoní mountain in the Cayna district is seamed with narrow veins of brown hæmatite, galena and blende, and there is just a chance that skilful prospecting may hereafter reveal some metalliferous deposit of importance. Outcrops of coal of excellent quality are known to exist about 2 leagues away from the village of Margash, but the author was unable to visit the locality on account of the difficulty of securing guides. Magnificent specimens of the coal were shown to him.

On the whole, however, it is rather a melancholy tale that he has to tell, of the province and its mineral resources: wasteful working in the ancient days, so that mine after mine has caved in, and could not now be reopened; scores of mining concessions, which are practically valueless from the industrial point of view; and so forth. The staple industry at present is agriculture, which is flourishing. L. L. B.

THE MINERAL FIELD OF HUAROCHIRÍ, PERU.

La Minería en Huarochirí. *By* J. L. Icaza. *Boletín del Ministerio de Fomento*, 1903, *No.* 7, *pages* 91-92.

Out of 200 metalliferous mines opened up in this area, 18 only are now in active operation. Most of them work silver, copper and lead-ores, and in a very few gold is got. Coal of excellent quality has been proved in the districts of San Lorenzo de Quinte and San Mateo y Carampoma;

numerous other outcrops are known to exist, but remain for the present unexplored. A cinnabar-mine, long worked in the Carampoma district, is now abandoned, and the workings have fallen in. Tin, zinc and iron-ore deposits are abundant, but, under present conditions, fail to attract the serious attention of prospectors. The want of capital is the sole obstacle to the revival and further development of a prosperous mineral-industry in the province of Huarochirí. L. L. B.

NICKEL AND TUNGSTEN-ORE DEPOSITS IN PERU.

Los Yacimientos de Níquel de Rapi y los de Tungsteno de Lircay. *By* Eduardo A. V. de Habich. *Boletin del Cuerpo de Ingenieros de Minas del Perú, No.* 11, 1904, 39 *pages, with* 23 *figures in the text and* 2 *plates.*

The nickeliferous deposits are situated in the rugged, mountainous province of La Mar, in one of the most remote districts in Peru, the journey thither from Lima occupying from 12 to 14 days. The outcrops are not always easy to locate, on account of their being masked by the luxuriant vegetation, but they have been traced over a distance of 12 miles or more on the Rapi estate, near the Rio Pampas. The general strike is at first east and west, and thereafter invariably north-north-east and south-south-west; the dips of the reefs or veins are variable both in amount and in direction. In thickness, the metalliferous deposits range from 2 to 50 inches, and the most abundant are the sulphantimonides, sulpharsenides, arseniates and hydrosilicates of nickel, with which are variously associated smaltine, native silver, pyrites, galena and spathose iron-ore. The gangue is almost invariably quartz, and in some cases this is gold-bearing. At one locality, the "country" is spoken of as slaty rock, but, as a rule, it would appear to be a "contact-rock," the outcome presumably of metamorphism induced by some igneous intrusion. Only one analysis is cited, of a sample which yielded 20½ per cent. of metallic nickel with traces of silver.

Water-supply is abundant, and the fall of the mountain-torrents and rivers is so considerable as to be capable of furnishing adequate motive power for mining operations and ore-treatment on a large scale: it may be mentioned that the Rapi estate lies at a level of 11,480 feet above the sea. Skilled labour for the mines would be doubtless available from the neighbouring province of Huancavelica. Such roads as there are may be said to have made themselves: the opening-up of proper means of communication is imperative, not only on account of the nickeliferous deposits, but on account of the other minerals (gold, silver, copper, coal, etc.), which are reported as existing in abundance in the mountainous region here described.

The tungsten-deposits of Julcani are situated some 3 leagues distant from Lircay, the chief town of the province of Angaraes, which is reached (partly by railway, partly by road) in some 5, 8 or 10 days, according to circumstances, from Lima. The deposits consist essentially of two great reefs, the upper called the Rosary and the lower the Souls (Las Animas), the intervening mass of rock being full of metalliferous veins cutting each other at all angles. The strike is west-north-westerly and east-south-easterly, sensibly parallel with the crests of the mountain-ridges, and the pitch is practically vertical. The name "Rosary" is applied to the upper deposit, because it consists of a series of "pockets," about 5 feet broad, connected by metalliferous "stringers," like huge beads loosely strung together: in it the wolfram-ore is more abundant than in the lower. In both the

gangue is quartz, sometimes auriferous, and pyrites is locally abundant. The ore is a tungstate of iron and manganese, steely grey, with a metallic lustre; the hardness is 5·5, and the specific gravity varies from 7 to 7·5. On analysis the ore is shown to contain 55·9 per cent. of tungstic acid and 5·9 ounces of gold per ton. The country-rock is diorite, abundantly pyritiferous, and containing in many places masses of very pure kaolin. East of the tungsten-deposits are considerable outcrops of somewhat impure pyrolusite.

The climate is extremely cold, the water-supply is not precisely abundant, but the roads (although of steep gradient) are fairly good. As mining is the principal industry of the province, skilled labour at moderate wages is easily available. So far, the Julcani deposits have only been worked for the sake of the gold, which is best extracted from the ore by the chlorination-process. L. L. B.

THE MINERAL RESOURCES OF THE PROVINCES OF MOQUEGUA AND TACNA, PERU.

Informe sobre la Provincia Litoral de Moquega y el Departamento de Tacna. By Francisco Alayza y Paz-Soldán. *Boletín del Cuerpo de Ingenieros de Minas del Perú, No.* 3, 1903, 123 *pages and* 6 *plates.*

This memoir embodies the results of an official mission, with which the author was entrusted by the Peruvian Government, to enquire into the mineral resources of the regions mentioned in the title.

Taking first the district of Moquegua itself, beds of rock-salt, frequently associated with gypsum, appear to be of fairly-widespread occurrence. Some 13½ leagues south-east of the town, in the ravine of Toquepala, are mines working ferruginous quartz-reefs in the granite, which are mineralized with copper-ores (chrysocolla, malachite, azurite, cuprite, etc.). The percentage of metallic copper varies from 10 to 11, with mere traces of silver. The investment of a small amount of capital in judicious prospecting is recommended, as likely to secure a profitable return. The 70 miles of railway from Ilo to Moquegua, constructed in 1873, was destroyed by the Chilian troops in the war of 1880, and its reconstruction is now imperative.

In the district of Ilo, cupriferous veins are, and have been, worked in the granites, 4 leagues north of the town that gives its name to the district. The ore from the San Juan vein assays on an average to 20 per cent. of metallic copper; that from the San Juanito mine yields 28 per cent. of metallic copper and 20 parts of gold per 1,000,000. The facilities in regard to transport and fuel-supply are excellent: the two main requisites are modern plant and methods of working, and a reasonable amount of fresh capital. The last statement applies with additional emphasis to the mines formerly worked by a Chilian company, in the Cilatilla range, 2½ leagues north-east of Ilo.

The most important rock-salt deposit in the whole of Peru is opened up at a distance of 7 leagues from Pacocha, and 1½ leagues from the Pacific seaboard. The salt is of prismatic structure and of great purity. Other rock-salt deposits occur at Loreto, Osmore and in the Pampa Colorada.

In the district of Torata, prospecting work has been done in the Talabaya gulch, on what appeared to be very promising veins of argentiferous galena, but the quantity of ore in sight is too small to repay working. The same remark applies to the metalliferous deposits of Huairurí.

In the district of Carumas the author draws particular attention to the coal-bearing beds, which extend, indeed, into the districts of Ichuña, Ubinas,

Puquina and Omate. The general strike in Carumas is north-east and south-west, with a south-easterly dip varying from 0 to 90 degrees. The strata have been much dislocated by volcanic phenomena. Nine analyses of Carumas coal are given, including in that term lignite, bituminous coal and anthracite. The quality is good, and the amount of ash (in nearly all cases) surprisingly small. But before there is any chance of successful mining operations in the district, a railway must needs be built and tolerable cart-roads provided.

The people of the neighbourhood work the native sulphur-deposits associated with the extinct volcano of Ticsane, but the sulphur is not of particularly excellent quality, nor does it occur in such quantity as to repay working on a large scale. Hot springs of medicinal value occur at Putina and Cadena.

The district of Ichuña appears to be characterized by roads nearly as bad as those of Carumas, and by the absence of bridges. The most distinctive outcrops of the coal-bearing beds are in the Pubaya gulch, where three seams are seen, of a total thickness of 7 feet. Five analyses of coal are given, the fixed carbon averaging 70 per cent.; volatile matter, 17 per cent.; and ash, 14 per cent. The coal is of a semi-bituminous character, and less pyritous than that of Carumas: the strata are, moreover, less disturbed than in the last-named district. Silver, lead and copper-ores were worked in the decade from 1840 to 1850, but were then abandoned, and the workings have mostly fallen in.

The same tale of bad roads is recorded from the district of Ubinas as from the others just described. The author devotes a good deal of space to considerations on the great volcano of Ubinas, which rises to a height of more than 16,000 feet above sea-level. Deposits of native sulphur of excellent quality are worked in a primitive fashion by the Indians of the neighbourhood, and the great borate (ulexite)-deposits of the Pampa de Salinas are well-known. Three analyses of the boro-natro-calcite are given, and the author states that the important workings of the British company, suspended for some time past, will now be restarted.

No serious work has yet been done on the anthracite and other coals of Querala; nor, of late, on the blende and galena of the Chimbuyo range. The question of transport is, in this connexion, a difficulty which appears likely to prove insurmountable for a long time to come.

The coal-bearing beds of the districts of Puquina and Omate are regarded by the author as unworkable. At Omate and Ullucán are thermal springs of medicinal value.

The usual evidences of moribund vulcanicity, in the shape of geysers, thermal springs, and immense deposits of native sulphur, are not wanting. In the department of Tacna, copper-ores of good quality occur in the Tojenes gulch, and would repay working on a large scale, and concentrating on the spot. Similar ores, some very rich in silver, occur in other districts, but the workings of Mecalaco (after a spasmodic attempt at revival in 1898) have been finally abandoned. L. L. B.

PETROLEUM IN THE PROVINCE OF PAITA, PERU.

El Petróleo en Paita. By P. I Seminario and F. O. Lopez. *Boletin del Ministerio de Fomento*, 1903, *No.* 2, *pages* 16-19.

The Tertiary strata of this province are rich in sulphur, salt, gypsum and petroleum. The last-named is the only mineral product worked there at

present, and the industry has already attained great dimensions. There is evidence to show that the oil-belt extends right across the province northward into the neighbouring province, where the oil-wells of Zorritos are in full yield. The oil occurs in coarse sands at very various depths, and is associated with a large amount of bitumen, veins of which are traced into the hills, from 2 to 4 leagues distant from the Pacific seaboard. In some deep ravines between these and the ocean are outcrops yielding a petroleum, which, owing to the extreme heat of the sun in that climate, has lost its volatile constituents and consequently its inflammable properties.

It is only in the northern portion of the province that the petroleum-deposits are being worked at present; at Negritos, 6¼ miles south of Talora, and at Lobitos, north of that town. At Negritos, the oil is got from 79 wells (many of which are on the sea-beach) at depths varying from 300 to 1,400 feet below the surface. The oil got from the greatest depths is rich in kerosene and benzine. Natural gas occurs in great abundance, and is used on the spot as fuel. At present, the output of oil exceeds the local demand for it, but the rapid development of manufacturing industries on the Pacific coast is expected to change this condition of affairs before long.

L. L. B.

IRON-ORES OF TAMBO GRANDE, PIURA, PERU.

Los Yacimientos de Fierro de Tambo Grande. *By* Pedro C. Venturo. *Boletín del Cuerpo de Ingenieros de Minas del Perú*, 1904, *No.* 8, 37 *pages and* 6 *plates.*

Tambo Grande, the chief town of the district of that name, in the northernmost department of Peru, namely Piura, is 22 miles east of Sullana, where the railway to Payta (the nearest harbour on the Pacific seaboard, 38 miles distant) may be reached. Water is, on the whole, scarce in the district; really abundant rains occur only every 5 or 7 years, and then much of the land usually given up to goat-pasturage, is temporarily turned into arable. Tambo Grande itself, however, lying on the banks of the Piura river, is surrounded by fields of cereals and market-gardens (wherefore provisions are cheap), and labour for mining purposes should not be difficult to obtain.

The iron-ore forms an entire hill astride of the road from Piura, causing the road to bifurcate; one of the branches leads straight into the town, and the other leads to the Tambo Grande farmstead. The ore crops out in the very streets of the township, and is exposed in the central square, the town being really built over part of the ore-deposit. The ore is a red hæmatite varying in structure, for it is in places compact, in others earthy, and in yet others cavernous. It often contains quartzitic and jaspery inclusions, or concretionary masses of calcite. Two samples of ore enclosing such extraneous material, nevertheless, yielded 36·4 and 26·2 per cent. of metallic iron respectively. These results are far from representing the average quality of the hæmatite, which is generally pure, containing (as shown by assay) 51·5 per cent. of metallic iron. It is free from phosphorus, and its specific gravity averages 3·21. The scarcity of good stratigraphical sections makes it difficult to dogmatize as to the origin of the ore-deposit; but, on the whole, the author inclines to conclude that it is the outcome of sedimentation in a lake-basin, or at the bottom of an ancient sea. The ore was probably deposited in the form of brown hæmatite, which has been altered and dehy-

drated in the course of ages to red hæmatite. The amount of ore in sight is estimated at about 1,180.000 tons; but it seems probable that the deposit extends over a much larger area than can be proved at present.

The coal-mines of Jibito, yielding an excellent coal, appropriate for metallurgical purposes, are about 84 miles distant. Unworked coal-deposits are said to exist at Tangarara and Mallares, but those previously reported to occur around Tambo Grande itself are mythical. Use might be made of the lignite-deposits of Tumbes, which formed the object of official investigation as long ago as 1866 and 1867. L. L. B.

MINERALOGY OF THE MUSO EMERALD-DEPOSITS, NEW GRANADA.

Sur les Minéraux associés à l'Emeraude dans le Gisement de Muso (Nouvelle-Grenade). By H. HUBERT. *Bulletin du Muséum d'Histoire Naturelle*, 1904, *pages* 202-208.

In this paper the author describes minutely such minerals associated with the Muso emeralds as had not hitherto formed the subject of any detailed investigation.

In the midst of an abundantly-fossiliferous bituminous limestone and of black shales of Neocomian age, occur veins the constituents of which are essentially crystalline. In some cases these are fine-grained and positively form a rock ("Emerald-limestone"); in others, they are built up of big crystals which merely coat the walls of the fissures.

The mass of the Emerald-limestone is made up of calcite, amid which the unaided eye may detect innumerable tiny crystals of pyrites, and, less frequently, fair-sized crystals of dolomite and parisite. Microscopic examination reveals the presence of quartz, albite and emerald, and, in a secondary degree, that of rutile and limonite. From the crystallographic study of the albite-felspar the author is enabled to arrive at the important conclusion that the action of mineralization at Muso was strictly confined to the fissures in the strata, and that the crystalline minerals were not developed by "imbibition in the limestones."

The emeralds for which the deposit is worked are found in the geodes: they are well-known for their splendid coloration and their uniform transparency. The biggest crystals attain a length of several inches. Calcite is the most abundant associate of the emerald in the geodes; and quartz bulks largely too, whereas it is not very abundant in the Emerald-limestone. The author describes also the different types of pyrites, and enumerates, besides the minerals already mentioned, anthracite, gypsum, fluorspar, pyrophyllite and allophane as (less common or rare) associates of the Muso emeralds.

At present the deposits are worked opencast, the deep workings started by the Spaniards having been abandoned since the time when the country declared itself independent of Spain. The known quarterly output is extremely variable: it is more than suspected that the losses by theft are enormous, and many veins are not worked at all. L. L. B.

NEW QUICKSILVER-MINERALS FROM TEXAS, U.S.A.

1. *Das Vorkommen der texanischen Quecksilbermineralien. By* B. F. Hill; *and* 2. *Eglestonit, Terlinguaït und Montroydit, neue Quecksilbermineralien von Terlingua in Texas. By* A. J. Moses. *Zeitschrift für Krystallographie und Mineralogie*, 1904, *vol. xxxix., pages* 1-13, *with* 6 *figures in the text.*

The first paper gives a brief description of the quicksilver ore-deposits of Terlingua, Brewster County, Texas. These lie partly in the massive Lower Cretaceous limestones, and partly in the thinly-bedded marls, slates and impure limestones of the Upper Cretaceous. All these strata are cut by dykes, or broken into by bosses of ancient volcanic rock (phonolites, andesites and basalts).

Those ore-deposits which are at present of the greatest industrial importance occur chiefly as brecciated belts (primarily connected with fissures) in the Lower Cretaceous Edwards and Ouachita limestones. The fissures are frequently metalliferous, and always infilled with calcite: at some points aragonite is abundant, and gypsum, iron oxides and wad are among the associated minerals. Quartz is never found in association with the ores. The chief ore is cinnabar, which occurs sometimes in magnificent ruby-red crystals up to $\frac{3}{4}$ inch long, intimately intergrown with calcite and native mercury; sometimes it occurs in great semicrystalline granular masses, or again in compact masses, varying in colour from vermilion to dark reddish-brown. Native mercury is of fairly common occurrence, and some cavities in the limestone have yielded more than 20 pounds in weight of it.

The Upper Cretaceous ore-deposits form reefs in the Eagleford Slates, and are not so conspicuously associated with calcite as those just described. Pyrites, on the other hand, occurs in considerable quantity.

The second paper deals with the new quicksilver-minerals, which appear to be confined to the Lower Cretaceous deposits, and were in fact all obtained from one drusy cavity in a calcite-vein.

The mineral called eglestonite, after the late Prof. Th. Egleston, is an oxychloride of mercury, corresponding in chemical composition to the formula $Hg_6Cl_3O_2$. The tiny brownish-yellow crystals, of a resinous lustre, are hexakisoctahedra: some exhibit cavities containing native mercury; they rarely measure as much as $\frac{1}{2}\frac{1}{5}$ inch in diameter, and blacken rapidly on exposure to the sun. The hardness is between 2 and 3, and the specific gravity is 8·327.

Terlinguaite is the name restricted by Dr. Moses to the monoclinic oxychloride of mercury (Hg_2ClO) here described. It occurs in very small sulphur-yellow crystals, of hardness 2 to 3, and specific gravity 8·725. The colour slowly darkens to olive-green on exposure to the air. It is found associated with the eglestonite, from which, however, it is easily distinguishable. A third mineral, montroydite, so named after Mr. Montroyd Sharpe, one of the Terlingua mine-owners, is found with the two foregoing, in the form of velvety incrustations of orange-red acicular crystals, with which are associated some dark-red larger crystals. These belong to the orthorhombic system, possess a vitreous lustre, and a hardness less than 2. Their specific gravity has not been determined, but analysis shows the mineral to be a simple oxide of mercury (HgO). In addition, crystallized calomel, and an undetermined yellow quicksilver-mineral, were obtained from the same drusy cavity. L. L. B.

THE MINERAL RESOURCES OF THE MENADO DISTRICT, CELEBES.

Geologische en mijnbouwkundige Onderzoekingen in de Residentie Menado gedurende het Jaar 1902. By M. Koperberg. *Jaarboek van het Mijnwezen in Nederlandsch Oost-Indië*, 1903, *vol. xxxii., pages* 170-178, *and* 1 *plate.*

The search for ore-deposits in this district continues unabated, but appears to have been confined in 1902 to the north-western portion of it. In the Kaidipang division, prospecting revealed veins of iron and copper-pyrites, more or less auriferous, associated with quartz. Along the Pagoejama river, in Gorontalo, occur gold-placers: and this statement applies to several other rivers in the same division. In the hilly country south of the Pagoejama, prospectors for ores report unsatisfactory results, the only occurrences worth mentioning being some veins of pyrites.

In the andesite- or porphyrite-breccias along the Bodi valley, quartz veins mineralized with pyrites, galena and blende, and yielding a variable proportion of gold, occur. Some manganese-ore has been found at Cape Torawitan, but one does not gather that it is proved to occur in sufficient quantity to be of industrial importance. L. L. B.

THE MINERAL WEALTH OF NEW CALEDONIA.

Rapport à M. le Ministre des Colonies sur les Richesses minérales de la Nouvelle-Calédonie. By E. Glasser. *Annales des Mines*, 1903, *series* 10, *vol. iv., pages* 299-392 *and* 397-536, *and* 3 *plates; and* 1904, *series* 10, *vol. v., pages* 29-154, 503-620 *and* 623-701, *and* 3 *plates.*

In this lengthy memoir the author details the results of the investigations which he made, in the course of a journey undertaken in 1902 on behalf of the French Government, into the mineral resources of their greatest island-colony in the Pacific. The absence of railways and of regular coasting-steamers, the small extent of really-good roads and the bad condition of the bridlepaths, were the main difficulties which beset him.

The first few chapters are devoted to a description of the physiography and general geology of the island, which was probably separated off from Eastern Australia before the end of the Mesozoic era, and from New Zealand in late Cretaceous or early Tertiary times.

Archæan rocks, mainly represented by mica-schists, form the core of the northern portion of New Caledonia, running up there indeed into high peaks. Granite crops out among the serpentines at two localities, at any rate, in the southern portion of the island. The Archæan rocks are flanked on either side by a series of sedimentary deposits, ranging from pre-Cambrian to Tertiary. Sheets and dykes of eruptive rocks are intruded among the sedimentaries; of these eruptives, the comparatively-recent serpentines are the most widespread and the most interesting from the industrial point of view, since with them are associated all the nickel, cobalt and chrome-ores, and the more important accumulations of iron-ore known in the colony. Coal occurs in the less ancient sedimentaries [Cretaceous] and gold, copper, argentiferous lead-ore, ores of zinc, antimony, mercury, tungsten, etc., in the Archæan massif. Coral-reefs, living and dead, form an almost continuous belt round the island.

We are reminded that it was in New Caledonia that hydrosilicates of nickel, since then discovered in various other regions of the globe, were for

the first time pronounced to be workable metalliferous ores; and after various crises, which the author describes in detail, the annual output rose in 1901 to 133,676 tons. Exports have increased almost continuously from 37,467 tons in 1896 to 129,653 tons in 1902. The green silicates (garnierite, noumeite) were alone worked in the earlier years, until it was discovered that the brown mineral ("nickel-chocolate") frequently associated with them, was just as rich in nickel. All the varieties of nickel-ore in the island are exclusively confined to the peridotite-massifs, but not to one particular type of peridotite: they are found equally in fresh crystalline rock and in highly-serpentinized material, decomposed by weathering into clays. In all cases, the ore occurs in such portions of the massif as have been near enough the surface to be subject to the influence of atmospheric agencies. The difficulty of describing the different kinds of nickel-ore is pointed out, as there are innumerable instances of the passage of one variety into the other.

Nowadays, no ores are worked nor are indeed saleable unless they contain a minimum of 7 per cent. of metallic nickel, after dessication at 212° Fahr. It is true that there are exceptions to this rule, the Nepoui mine having recently exported to America ores containing only 6 and 6½ per cent. of the metal. The minimum has been fixed, not so much in view of metallurgical exigencies, as in consequence of the heavy cost of transport. The general practice is to mix low-grade and high-grade ores in such proportions as to reach the desired tenour. This, of course, necessitates very careful sampling and assaying. The dried 7 per cent. ore, on the spot, is worth from £1 15s. to £2 per ton (see, however, below): prices were slightly lower in 1902 than the previous year and showed a tendency to go down lower still. New mines, of late years, have been opened up chiefly on the western coast of the island, while operations on many rich deposits of the eastern coast have been conducted with renewed activity. Nevertheless, it was expected that the total exports of nickel-ore during 1903 would show a diminution, as compared with those of the two preceding years. Canadian competition and the shrinkage of the general demand for nickel count for much.

About 40 pages are devoted to a detailed description of the nickel-mines on the eastern and western coasts, and 8 pages to a description of the workings that are now abandoned. The question of the reserves of untouched nickel-ore in the interior of the island is then discussed at some length, and the author marshals the evidence in favour of the view that the nickeliferous deposits are, speaking generally, superficial. However this may be, the area over which they may be still expected to occur is vast enough to furnish materials for an extensive mineral-industry for many years to come. The methods of working, transport-facilities, cost of labour, etc., are then dealt with in detail, and taking every possible item into consideration, the author reckons the minimum prime cost of a ton of dry ore at 25 to 29 shillings. At the time of his visit the sale-prices left an ample margin of profit.

The author then proceeds to consider the statistics of export and consumption, the available markets, and the possibilities of development of the nickel-industry in New Caledonia. He thinks that it would be advantageous to establish smelting-works in the island, and enters into minute calculations on this subject. He holds that, as against Canadian competition, all the natural advantages are in favour of New Caledonia, whose nickel-ores are richer, purer, more cheaply worked, and more easily smelted. He admits that Canada has in her favour abundant and excellent labour, appropriate methods of working on a large scale, good transport-facilities,

and well-equipped smelting works. Improvement in all these respects is by no means impracticable, however, even in the remotely-situated French island-colony.

The third part of the memoir deals with the other ores that are associated with the nickeliferous serpentines.

Cobalt, the all but inseparable companion of nickel, has in New Caledonia been redeposited, in conjunction with manganese, in nodules or concretions in the red clays; while the nickel, obedient to its marked affinity for magnesium, has combined with it in the form of hydrosilicates precipitated among the more or less serpentinized peridotites. The red clays represent a further stage of decomposition of these rocks. It is rare to find ores which, even after careful sorting and washing, yield more than 10 per cent. of oxide of cobalt. A considerable amount of iron peroxide and monoxide and dioxide of manganese is always intimately associated with it. On the whole, these ores may be defined as a cobaltiferous asbolite or wad. Their occurrence in the colony was hardly noticed until 1876, and it was only in 1883 that they began to figure regularly among the exports, at the rate of 2,000 to 3,000 tons *per annum*. The total output in 1901 from 35 workings amounted only to 2,552 tons, but in 1902, on account of the continuous rise in prices, no less than 74 mines were at work, producing a total of 7,512 tons. Some of the principal cobalt-mines are described in detail, as also the methods of working, sorting and washing the ores. Hand-labour, in respect of this preliminary preparation of the ore, appears to be both somewhat costly and wasteful; but the introduction of mechanical screeners and washers, on account of the great variation in grade of the ore, might not in the long run prove much more advantageous. The cost-price of a ton of washed ore put down at Nouméa ranges from £5 16s. 10d. to £6 5s. per ton, while the selling price varied (at the time of the author's visit) from £13 5s. per ton of 4 per cent. ore to £30 per ton of 8 per cent. ore. The supply on European markets has since then exceeded the demand, and prices have gone down considerably. New Caledonia remains by far the greatest cobalt-producer in the world, the output from all other regions being by comparison insignificant, reaching indeed only a tenth of the tonnage got from the French colony. A word of warning is given as to the improvident methods of working which obtain there.

Chrome-iron-ore occurs with remarkable constancy in the great serpentine-formation of New Caledonia. It is found either as a rock-mass among the peridotites, weathered and unweathered alike; or in the form of grains among the red clays which are their ultimate decomposition-product. Consequently, the workings may be severally described as reef-workings or placer-workings. Exports began with 500 tons in 1880, and increased enormously in the 'nineties, the total export for 1901 amounting to 17,600 tons, got from 10 placer-workings. The ore is of such excellent quality, that, without picking or washing, it averages 50 to 55 per cent. of chromium sesquioxide, or even more. One gathers, however, that at present prices, the smaller placer-workings cannot be making very great profits. Mining operations, if pursued more methodically and on a larger scale, would spread the prime cost over a greater output and hence ensure a steadier and higher profit. The most serious rivals of New Caledonia in the production of chrome-iron-ore are Russia, Turkey in Asia, New South Wales and Canada.

Red hæmatite, in the form of "scoriaceous blocks," occurs on the

flanks and crests of the peridotite-massifs, and is the material with which the Kanakas build their cairns. Analysis shows it to be a good and rich ore. The author does not think that it can be regarded as the gossan of a deep-lying vein-deposit; but its relation in certain localities to the chrome-iron-ore suggests that both ores were originally derived from a massive or bedded deposit of chromite and magnetite, which was the outcome of igneous segregation. Hæmatite also forms the nucleus of the rough grains which lie in thick and extensive beds on the gentler hillslopes: the pulverulent shell or crust of these grains consists of a hydrated oxide of iron, and they yield, after calcination, something like 50 per cent. of metallic iron. Further, the serpentinous massifs are in many places mantled by thick masses of a red, impermeable, unctuous, more or less plastic material which may be regarded as consisting of iron-ores, highly siliceous at some points, highly ochreous at others. The author discusses the reasons which now and for some time to come are likely to forbid any serious attempt at working the hæmatites, etc., of New Caledonia.

Copper-ores occur both on the eastern and western coasts, and in the interior of the island, but working was not seriously begun until 1873. From that date until 1902, more than 50,000 tons of ore and about 1,000 tons of rich matte have been exported. The La Balade group of deposits are mainly copper-pyrites interbedded with and impregnating hornblende and glaucophane-schists. These mines were abandoned, perhaps rather too hastily, in 1884. In the La Pilou group, cupriferous quartz-reefs are seen to cut vertically through black slates: they carry, besides various ores of copper, lead, zinc, silver and iron-ores. Abandoned for a time, working on these deposits was re-started in 1897 by a British company. But capital was frittered away in useless expenditure, and in a disastrous attempt to treat the ore on the spot, instead of exporting it to Australia; bankruptcy ensued in 1902. However, a third endeavour is to be made to work these mines.

Gold is not being mined in New Caledonia at the present time, but between 1871 and 1873, and again from 1876 to 1878, the gold-mining industry was fairly active, the value of the total output for the years mentioned being about £26,000. At Fern Hill mine, a quartz-reef at the contact of black schists and mica-schists was worked in 1872, mining was twice abandoned and twice restarted; but the conclusion was arrived at in 1888, as the result of further exploration-work, that the distribution of the precious metal was too capricious and the deposit on the whole too poor, to offer favourable prospects. Deep down, the native gold at Fern Hill gives place to auriferous pyrites, and it is suggested that the facilities offered by modern methods of treatment should largely modify the unfavourable judgment arrived at in 1888. Gold occurs among the glaucophane-schists of the Tiarî massif, and in the sands brought down by the rivers in the northern district of the island. Auriferous deposits have also been explored in the centre and south; some have been worked more or less spasmodically, and then abandoned.

Argentiferous lead-ores occur at various localities in the north of New Caledonia, but have only been mined at one place—the Mérétrica mine, discovered towards the end of 1884. Work was started here in 1886, and finally abandoned in 1898: the proportion of silver averaged more than 1 part per 1,000 of pig-lead. The deposit, yielding cerussite at the outcrop, and galena (with pyrites and blende) deeper down, occurs among black slates which are traversed by a greenstone-dyke. Hand-specimens of the cerussite are

spangled with native silver, and the amount of the precious metal therein is said to have averaged 12 to 15 ounces per ton of ore: the assays of the sulphidic ores were far less favourable, the amount of silver averaging from 3 to 6 ounces per ton. The author tabulates the results of 21 analyses made in 1898, but he has not been able to check them himself.

Zinc occurs as an unwelcome impurity in the copper- and lead-ores of the island, but actual zinc-ore deposits have not been discovered there so far.

Antimony-ores were worked at Nakety for a year or two in the early 'eighties. Under present economic conditions, however, it will be long ere the workings can be restarted with any hopeful prospect.

Cinnabar and *native mercury* are known to exist at several localities, but no information is available at present as to the actual extent or value of the deposits.

Platinum has only been reported so far from one locality in the island: it occurs, in very small quantity, in association with gold, in the sands of the Andam streamlet. Its original matrix is unknown. The sands of the rivers which flow down from the great serpentine-massifs have not as yet been systematically searched for platinum, and so it is possible that future exploration will reveal unsuspected deposits of the precious metal.

Manganese-ores occur in New Caledonia, although they are not of immediate industrial importance.

Tungsten in the form of scheelite (tungstate of lime) has been proved at Kouaoua, in the Faja valley, but it is questionable whether the deposit is sufficiently rich to repay working.

Coal is considered in the fifth part of the memoir: it was the first useful mineral to be discovered in the colony, as the coal-bearing rocks extend over coastal districts of comparatively-easy access. The seams, however, have not been worked so far and some observers are doubtful as to the possibility of utilizing them industrially. The coal-bearing strata (alternating shales and grits) are the uppermost of the sedimentary formations of the island, and are overlain by the peridotites: the palæontological evidence points to an Upper Cretaceous age, and so the coal-seams of New Caledonia date from about the same period as those of Westport in New Zealand. There is otherwise no sort of analogy or resemblance between them. Underlying the coal-formation unconformably are felspathic schists of Triassic age: between the two there sometimes intervene contact-metamorphosed rocks of Liassic and Upper Jurassic age. The coal-belt can be traced afar off by its characteristic bare escarpments of white to pink felspathic grit (a rock which is very friable), and extends along the western coast from Mont Dore to Mount Kaala, a distance of 180 miles. Despite this great extent, however, the author is inclined to agree with the opinion expressed by Mr. Heurteau in 1876, that many years must elapse before coal-mining can be carried on with real success in New Caledonia. The coal may prove a valuable asset later on.

The three chief coal-fields are those of Nouméa, Moindou, and Poya: there are, besides, six smaller fields known, one only of which (that of Voh) is of any considerable extent. A detailed description is given of all these, followed by analytical tables, showing that the mineral varies in character from anthracite, through bituminous coal, to lignite. The bituminous coal of the Portes de Fer (Nouméa) burns with a short flame, has in some instances a heating-power of 7,200 calories, is quite equal to Australian coal for boiler-firing, and yields fairly-good coke. Other coals in the same field have

also been shown experimentally to be suitable for industrial purposes, but it is thought that the coals of the Moindou basin will not prove easy to use. The little evidence at present available in regard to the regularity of the seams is in many cases unfavourable, and steep and rapidly-changing dips are to be expected. On the whole, the natural conditions and the difficulties of transport are such as to prevent New Caledonian coal from ever competing for shipping purposes with the coal of New South Wales or New Zealand. The annual consumption of coal in the French island at present ranges from 10,000 to 12,000 tons, and a gradual increase to 18,000 tons may be looked for when the railway from Nouméa to Bourail is completed (a somewhat remote contingency at present). If, however, the colony were to proceed to smelt its own nickel-ores, the coal-consumption would be sextupled.

The sixth and last part of this exhaustive memoir deals with the general economic conditions of the mineral-industry in New Caledonia: these are declared to be the reverse of favourable. Of the 3,000 men working on the mines, one-half are whites (nearly all ticket-of-leave men), and most of the remainder belong to one or other of the yellow races. The mining camps are of the roughest description, and drunkenness is the sole form of recreation. Pay is largely swallowed up in drink and in purchases (at exorbitant prices) at the camp-stores. The average daily wage ranges from 4s. to 5s. 6d. It is curious to note that the author is at one with the Government of the colony in favouring increased importation of Chinese labour. Commodities in the island are dear, and the taxation of industry and the dues levied from shipping are heavy. New roads and railways are among the most imperative requirements of the colony. L. L. B.

THE MINERAL RESOURCES OF SOUTHERN SUMATRA.

Einige Notizen zur Geologie von Südsumatra. *By* AUGUST TOBLER. *Verhandlungen der naturforschenden Gesellschaft in Basel*, 1904, *vol. xv.*, *pages* 272-292, *and* 1 *plate.*

Acting as geologist for two Dutch petroleum-syndicates, the author was enabled, in 1900-1903, to make very detailed observations on the rocks of Southern Sumatra and their fossil contents, and brought back with him to his native Switzerland considerable collections.

Describing first the older schists, and following Mr. R. D. M. Verbeek's classification, he points out that in the crater of the Ringgit volcano, near Bajur, petroleum wells up, and is undoubtedly derived from these schists. Hitherto, the occurrence of petroleum in Sumatra had never been recorded in strata older than the Tertiaries. Some of the green schists contain metalliferous ores, a fact already known, but the author cites new occurrences of them.

The richest oil-wells have been struck at very various horizons in the Lower Pliocene (4,900 feet thick), consisting in this region of blue clays passing locally into sandy shales and argillaceous fine-grained sandstones. Calcareous septaria, absent in the Upper Pliocene, are very characteristic of this lower division, which is also extremely rich in fossil mollusca.

Three groups of brown coal-seams are markedly characteristic of the Middle Pliocene division (2,000 feet thick), which consists of blue and brown clays, shales and (at the top) fine-grained, soft, shaly, pale-blue and white sandstones. Some of the lignitic seams are 40 to 50 feet thick, and

some contain slabs of silicified coal 4 to 12 inches thick. The author found, of course, plant-remains in the Middle Pliocene, but practically no marine fossils. Petroleum occurs in this division too, in workable quantities, and appears to be more especially concentrated at particular horizons, at the base of each of the brown-coal groups. The topmost brown-coal group is immediately overlain by the vast mass of the tufaceous sediments of the Upper Pliocene (3,300 to 5,000 feet thick), which bear witness to long-continued vulcanicity. No oil has been struck in this division of the Pliocene, nor is it likely to be. The other strata described by the author do not appear to be of economic interest, but his paper constitutes an excellent summary of the geology of Southern Sumatra. L. L. B.

SEARCH FOR COAL IN THE ATJEH VALLEY, SUMATRA.

Verslag eener geologisch-mijnbouwkundige Verkenning der Atjeh-Vallei gedurende het Jaar 1902. *By* P. J. Jansen. *Jaarboek van het Mijnwezen in Nederlandsch Oost-Indië*, 1903, *vol. xxxii.*, *pages* 179-184, *and* 2 *plates.*

Reports of the occurrence of coal having reached the Governor of the district, an official investigation was ordered, with the view of reserving the working of any such deposits to the state, and supplying the mineral so worked to the Atjeh light railway.

The oldest (sedimentary) geological formation in the region appears to be the Carboniferous Limestone, beneath which appears an ancient crystalline rock (gabbro). There is a series of younger sedimentaries (sandstones, conglomerates and limestones), probably of Tertiary age; and of more recent volcanic rocks (trachytes, andesites, tuffs, etc.). One of the reported coal-outcrops turned out to be the dark gabbro. In another case, a patrol is said to have brought back from a spot near Data Teureubéh several lumps of coal, but no seam has been found in place; and the "coal" is thought to have been semi-carbonized wood. Semi-lignitized plant-remains have been recorded on a former occasion from this river-valley.

On the whole, the evidence is all against the probable occurrence of workable deposits of coal, whether of Carboniferous or Tertiary age.

L. L. B.

THE AURIFEROUS PLACERS OF THE BATAK PLATEAU, SUMATRA.

Über die Goldvorkommen auf der Bataker Hochfläche. *By* H. Bücking. *Sammlungen des geologischen Reichsmuseums in Leiden: Beiträge zur Geologie Ost-Asiens und Australiens, vol. viii.*, 1904, *pages* 97-99.

From time immemorial these placers have been worked in a very primitive manner by the natives, the gold being fashioned by them into bracelets, finger-rings and ear-rings. Masses of auriferous sand and silt fill up the valley-floors, and the hollows and depressions in and between the limestone-rocks, which crop out on the hillsides. The "gold-sand," generally black, contains a quantity of magnetite and small crystals of zircon; on washing and re-washing this, the precious metal is obtained in the form of thin flakes and little grains.

With regard to the original *locus* of the gold, it is observed that a part, at least, must be derived from the decomposition of the auriferous pyrites contained in the eruptive rocks, the weathered residuum of which latter

occurs in the form of laterite in many of the placers. But pyrites is also found in the quartz-veins which traverse several of the limestones of the district; and there is not much doubt that the quartz is itself gold-bearing, since the natives wash for gold the detritus (often forming a deposit 10 feet thick) derived from the atmospheric degradation of the veins, while they cast aside the semi-lateritized, easily-crumbling blocks of eruptive rock.

On the whole, the deposits, so far as their primary origin is concerned, may be compared with the auriferous occurrences of Hungary and Transylvania; in both cases they are associated with quartz and iron-pyrites, precipitated from fumaroles and thermal springs, which were connected with the later phases of andesitic and trachytic eruptions. Auriferous deposits of considerable importance are said to exist on the south-western flank of the Longsuwattan mountain, but are at present inaccessible, as they lie within the territory of a warlike hostile tribe. L. L. B.

THE CANNEL-COAL FLORA OF NÝŘAN, BOHEMIA.

Beitrag zur Kenntniss des Cannelkohlenflötzes bei Nýřan. By F. Ryba. *Jahrbuch der kaiserlich-königlichen Geologischen Reichsanstalt*, 1903, *vol. liii., pages* 351-372, *and* 3 *plates.*

This paper is devoted to a description of plants not before found in the Nýřan cannel-coal, or otherwise but little known. The flora on the whole, if interesting, is poor. It consists of 79 species in all, 34 of which are ferns, 16 are Calamarians, and 12 Lycopods. Those species which are most abundantly represented in the cannel-coal belong to such forms as are known to range from the Middle or Upper (very rarely from the Lower) Carboniferous into the Lower Rothliegende. True Carboniferous types are numerous among the Nýřan species: and among the Lepidodendra are some forms which are exclusively Carboniferous. The evidence for the existence of purely Permian plants in the Nýřan flora is practically negligible. Indeed, so far as the palæobotanical evidence goes, the Nýřan cannel-coal belongs to the Upper Productive Coal-measures, and may be correlated with the uppermost Ottweiler beds of the Saar and Rhenish coal-fields. L. L. B.

PALÆONTOLOGY OF THE HERVE COAL-MEASURES, BELGIUM.

Note préliminaire sur les Caractères paléontologiques du Terrain Houiller des Plateaux de Herve. By A. Renier. *Annales de la Société Géologique de Belgique*, 1904, *vol. xxxi., Bulletin, pages* 71-73.

The results, to which the author's investigations have so far led him, are, briefly, as follows:—(1) The Coal-measures of the Herve plateau contain a fairly-rich fauna and flora, of distinctly Westphalian character, since they include the various species which are regarded by most authors as typical of the several horizons of that division of the Coal-measures. (2) The order of succession of the floras is practically the same as that established by Prof. Zeiller in the Valenciennes coal-basin, and repeated in the north of Belgium. (3) The presence of *Dictyopteris* in the Florent and Théodore seams, above which still come several workable seams, permits of the inference that the Flénus horizon (of which that genus is characteristic) extends, contrary to the generally-received opinion, into the east of Belgium. It may be noted,

by the way, that the seams with *Dictyopteris* yield a coal containing, on an average, only from 15 to 16 per cent. of volatile substances and 3 per cent. of ash. (4) The thickness of the strata between the Sidonie or Florent seam and the (basement?) Beaujardin seam, measured in the only-available continuous section (at the Hasard colliery), is about 1,640 feet. This comparatively-low figure points to a thinning of the Coal-measures in that district, and, if the same horizons can be proved at Liége, it will serve as a measure of the amplitude of the tectonic disturbances which cut off the Herve coal-field from that of Liége. L. L. B.

FOSSIL FLORA OF THE TONGKING COAL-FIELDS.

Flore Fossile des Gîtes de Charbon du Tonkin. By R. Zeiller. *Etudes des Gîtes Minéraux de la France : Colonies*, 1903, 328 *pages, and* 62 *plates.*

The detailed investigations recorded in this magnificent memoir have enabled the author to confirm triumphantly the inference, hotly disputed by others, which he had drawn as long ago as 1882, that the coal-formations of Lower Tongking are of Rhætic age. This conclusion is strengthened by the independent observations of Mr. Leclère in Southern China, who, it will be remembered by readers of the *Annales des Mines*, has shown that the analogous and neighbouring coal-basins of Yunnan and Kweichau are also of Rhætic age. It is true that there are also in Southern China seams of Coal-measure or Permian age. The Yen-bai coal-field of Tongking is, however, of much more recent date, its flora and fauna showing it to be of Upper Miocene or Lower Pliocene age at the earliest, if not Middle Pliocene.

The memoir opens with a brief description of the coal-fields from which most of the specimens studied by the author were obtained, and is accompanied by maps and sections, as well as by photographic illustrations of the fossils.

In Lower Tongking, the Hongay mines, with enormously-thick seams, producing anthracitic coals of a heating power varying from 6,900 to 7,800 calories, yielded in 1901 an output of 249,000 tons. The Kebao mines (said to include about 30 seams), with a much smaller output thus far, produce a similar coal. In both basins, a small portion of the output is mixed with 20 to 25 per cent. of Japanese coal, and bound together with pitch into briquette-fuel. The Dong-trieu anthracite-mines have hardly yet got into working order. In Annam, the Nong-sön coal-mine shows a single seam of workable coal varying in thickness from 20 to 40 feet: the output in 1902 amounted to about 24,000 tons. The mineral is still more anthracitic than that of Lower Tongking, containing only from 6 to 10 per cent. of volatile substances. L. L. B.

THE COAL-MEASURE FLORA OF THE DONETZ, RUSSIA.

Végétaux fossiles du Terrain Carbonifère du Bassin du Donetz : I. Lycopodiales. By M. D. Zaliesski. *Mémoires du Comité géologique, St. Pétersbourg*, 1904, *new series, No.* 13, 126 *pages, with* 11 *figures in the text and* 14 *plates.*

This memoir is the first instalment of a full description of such fossil plants from the Donetz coal-field as are to be found in the collections of the Imperial Russian Geological Survey. In it are described eleven species of *Lepidodendron* (three of which are new to science), one of *Lepidophloios*, two of *Ulodendron*, one of *Lycopodites*, three of *Lepidostrobus* (one new), two

of *Lepidophyllum*, two of *Bothrodendron*, one of *Bothrostrobus*, twenty-four of *Sigillaria* (six new), two of *Syringodendron* (one new), and two of *Stigmaria*. So much for the Lycopodiales: the other groups are to be dealt with in succeeding memoirs, and a final fasciculus is to embody the general conclusions which arise from the palæobotanical evidence. L. L. B.

CRYOLITHIONITE, A NEW LITHIUM-FLUOR MINERAL, FROM GREENLAND.

Sur la Cryolithionite, Espèce minérale nouvelle. By N. V. Ussing. *Oversigt over det kongelige Danske Videnskabernes Selskabs Forhandlinger*, 1904, *pages* 3-12.

This mineral was found in 1903, in the cryolite-mines of Ivigtut (Greenland), in the form of big transparent rhomboidal dodecahedra, some of which are as much as 7 inches in diameter. They are completely enveloped by cryolite, and contain many vacuoles with bubbles of gas and liquid. The mineral is colourless, its specific gravity is little short of 2·8, its hardness lies between $2\frac{1}{2}$ and 3, and its chemical composition is represented by the formula $Li_3Na_3Al_2F_{12}$ (fluoride of lithium, sodium and aluminium). Its discovery adds another factor, in the shape of the presence of lithium, to the remarkable resemblance between the mineral associates of cryolite and those of tin-ore deposits. Recent research has, moreover, strengthened the evidence in favour of the eruptive origin of cryolite. The new mineral recrystallizes on cooling after fusion, and also recrystallizes without difficulty by evaporation from an aqueous solution of it. It contains a larger proportion of lithium than any mineral so far known (11·4 per cent.). In cleavage and crystalline habit, in molecular build, in a word, it shows unmistakable analogies with the garnets. L. L. B.

DETERMINATION OF MINERALS BY THEIR SPECIFIC ELECTRIC RESISTANCE.

Sur un Caractère spécifique des Minéraux opaques. By G. Cesàro. *Bulletin de la Classe des Sciences de l'Académie Royale de Belgique*, 1904, *pages* 115-122.

The author points out that it does not appear to have occurred to anyone, so far, to make use, as a distinctive character of minerals, of the greater or less resistance which they offer to the passage of an electric current. Yet this is a property which it is easier to test than specific gravity or hardness, and can be utilized in the microscopic study of cast-iron, steel, and other alloys containing a metalloid which reduces the conductivity of the metal pure and simple.

The author's experiments were made with a dry battery, which ordinarily supplied an incandescent lamp: he attached two platinum-wires to the poles, and placed the free ends of the wires on the minerals which he examined. It seems probable that, in the case of cubic crystals of, say, mispickel, the specific electric resistance will be found to vary from one face to the next, or from one direction to the other along the same face. But this does not invalidate the practical utility of the method, whereby the author was able, for instance, to identify as native copper what might, to all appearances, have been chalcopyrite. Generally speaking, all transparent minerals, all silicates, "sulpho-salts" (including the silver-antimony ores, stephanite and polybasite) and oxides (excepting magnetite) are non-con-

ductors. With few exceptions, the conductors are confined to the opaque simple bodies, amalgams, sulphides, antimonides, arsenides, tellurides, etc. The author gives a detailed list of these, according to their degree of conductivity.

Cinnabar is a non-conductor, while metacinnabarite (of the same chemical composition) is a very good conductor. Pyrites varies in conductivity, according to the direction of the striations on its crystal-faces, while marcasite is a non-conductor. Moreover, it is found that the measurement of electric resistance in galena constitutes a quick method of determining the percentage of silver in the ore. Another advantage of the method is that the specimens thus tested are in no way spoilt or injured. L. L. B.

METHOD OF CALCULATING ANALYSES OF COAL.

(1) *Sur une Cause fréquente d'Erreurs dans l'Analyse centésimale des Houilles.* *By* Just Alix *and* Isidore Bray. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxix., pages* 215-216.

Premising that nearly all coals contain, in addition to iron-pyrites, a certain amount of calcium carbonate, the authors point out that the presence of this impurity must constitute a source of error in determining the percentage of carbon in the mineral. In order to form an idea of the proportions which this error may assume, they conducted a series of experiments on the gas-coal from the Montrambert mines, in the St. Étienne coal-field. They found that it contained on an average 4·99 per cent. of carbonate of lime, which would correspond to 0·56 per cent. of carbon. Now, this is a normal coal; but, in the case of such coals as the Tongking anthracite, practically seamed with calcitic veins, nearly ½ inch thick, the possible error would be much greater.

As this error leads one to suppose that a coal is richer in combustible carbon than it really is, the presence of carbonate of lime is a factor which should also be taken into account in determining the calorific value or heating-power of a coal.

(2) *Über die Berechnung der Elementaranalysen von Kohlen mit Bezug auf den Schwefelgehalt derselben, und den Einfluss der verschiedenen Berechnungsweisen auf die Menge des berechneten Sauerstoffes und die Wärmeeinheiten.* *By* C. von John. *Verhandlungen der kaiserlich. königlichen geologischen Reichsanstalt*, 1904, *pages* 104-111.

The author points out that a possible cause of error which vitiates the elementary analysis of coal, is that, as a rule, the hygroscopic water alone is determined, and that no account is taken of the chemically-combined water originally present in the constituents of the ash. The freer a coal is from ash, the more insignificant is this error; the general effect of which is, to minimize the proportion of ash and to magnify the proportions of hydrogen and oxygen.

Turning then to the calculation of sulphur, the author says that Prof. F. Schwackhöfer* reckons the so-called "detrimental" or combustible sulphur in his analyses, apart from the totals making up 100. This is of little consequence in cases where a coal does not contain much sulphur, but may lead

* *Die Kohlen Œsterreich-Ungarns und Preussisch-Schlesiens* (coals of Austro-Hungary and Prussian Silesia), second edition, 1901.

to considerable error in the case of a highly-sulphureous coal. An example is given, wherein the result is that the heating capacity of a coal has been tabulated too low by 300 to 400 calories or more.

An important question, which the author hopes will be determined by the Analysis Committee of the Fifth International Congress for Applied Chemistry, is the value to be set on the heat-equivalent of hydrogen, that is, whether the lower formula, 29,000 (wherein water is reckoned as steam) or the higher formula, 34,500 (wherein water is reckoned as a fluid) is in future to be the standard when making the necessary calculations in coal-analysis. In Germany, the first figure usually finds especial favour; but in France, as in the Laboratory of the Austrian Geological Survey, the second figure is adopted. These differences involve considerable discrepancies in the tabulation of the heat-units of any given coal. The same observation applies, especially in the case of brown coals and lignites, to the omission or inclusion of the percentage of water corresponding to the amount of oxygen determined as present in these minerals. International uniformity on the subject is a consummation devoutly to be wished. L. L. B.

ANALYSES OF HUNGARIAN COAL, ETC.

Mittheilungen aus dem Chemischen Laboratorium der königlich-ungarischen geologischen Anstalt. By ALEXANDER VON KALECSINZKY. *Jahresbericht der königlich-ungarischen geologischen Anstalt für* 1901, *pages* 174-183.

The Upper Mediterranean (Tertiary) coal of Kistapolcsány, County Bars, formerly known as Fenyökosztolány coal, yielded 58·52 per cent. of carbon, 0·77 per cent. of sulphur and 7·38 per cent. of ash. Its heating-power is estimated at 5,107 calories.

The coal from seam No. 1, at Jakfálva, County Borsód, yielded 6·48 per cent. of ash, and contained as much as 4 per cent. of sulphur. Its heating-power was estimated at 5,409 calories. The coal from seam No. 2 contains less sulphur, but yields double the amount of ash, and its calorific power is inferior.

Lignite from the neighbourhood of Derna, County Bihar, yielded 9·76 per cent. of ash, 43·49 per cent. of carbon, 1·84 per cent. of sulphur and 23·15 per cent. of water. Its calorific power was estimated at 4,281 calories. The lignite from Kartal, County of Pest, is superior in heating-power and in percentage of carbon (45 to 46), but contains, on the other hand, much more sulphur (3 to 4 per cent.).

An analysis is also given of the kaolin worked at Beryszász, and the results of an investigation of the salt-lakes of Transylvania are summarized. L. L. B.

ANOMALIES OF TERRESTRIAL MAGNETISM IN THE NEIGHBOURHOOD OF LIÉGE, BELGIUM.

Anomalies dans la Déclinaison Magnétique aux Environs de Liége. By — DEHALU. *Mémoires de la Société royale des Sciences de Liége*, 1904, *series* 3, *vol. v., No.* 3, 43 *pages and a map.*

The author has recently made a series of careful determinations of the magnetic declination at 17 localities in and around Liége, and his results lead him to the conclusion that there are in the Liége coal-field causes

which undoubtedly influence the direction of the compass-needle; and further that one source of this deviation must be sought in the colliery-heapsteads. Curiously enough, the deviation appears to be greatest in the case of pit-heaps which have been burnt.

With regard to other causes of deviation, a table drawn up by the author shows magnetic declination to increase generally eastward, a direction of increase which does not fit in with the normal distribution of the magnetic elements. The difference of declination between the extreme points plotted out on his map exceeds 20 minutes, more than 4 times what it should be. Consequently, there is no escape from the conclusion that the Liége coal-field is a region of magnetic anomalies, which are, perhaps, not unconnected with the great faults that are known to traverse it.

The author proposes to pursue his investigations along this line of research, if circumstances permit of his so doing. L. L. B.

MAGNETIC ANOMALIES OF THE PARIS BASIN, FRANCE.

L'Anomalie magnétique du Bassin de Paris. *By* Th. Moureaux. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences,* 1903, *vol. cxxxvii., pages* 918-920.

The observations carried out at 617 localities in French territory have revealed numerous irregularities in the normal distribution of the magnetic elements. Apart from the well-known anomaly of the Central Massif, traced directly to the influence of volcanic rocks, others have been discovered amid strata usually considered as quite innocent of any action upon the compass-needle. The most considerable and the most unexpected of these anomalies proves to be in the region defined geologically as the Paris basin. The records collected from 130 observing-stations, ranging from Upper Normandy to the Nivernais, indicate very marked deformation of the isomagnetic curves. Maps have therefore been drawn up, showing the differences between calculated and ascertained values. For instance, in regard to declination, the divergences are all positive to the east, and negative to the west of a line drawn from Fécamp south-eastward to Moulins, and passing through or near Rouen, Rambouillet, and Gien, at an angle of about 30 degrees with the geographical meridian. In regard to the horizontal component, the positive divergences form three zones alternating with zones of negative divergence.

A study of the maps based on these and other observations leads to the conclusion that, if the anomaly of the Paris basin be assignable to the action of magnetic rocks, the upper surface of the "perturbing mass" takes probably the form of a mountain-massif, overlain by more recent deposits, with peaks and summit-ridges at those points or in those zones which a consideration of the magnetic anomalies has shown to be centres of attraction. L. L. B.

THE MAGNETIC STORM OF OCTOBER 31st, 1903.

Das magnetische Ungewitter vom 31. Oktober 1903. *By* J. B. Messerschmitt. *Sitzungsberichte der mathematisch-physikalischen Classe der königlich bayerischen Akademie der Wissenschaften zu München,* 1904, *pages* 29-39, *and* 1 *plate.*

The period of minimum disturbances of the compass-needle came to an end a year or two later than had been calculated, and it was not till the

latter half of 1902 that a marked accentuation of these disturbances showed that the turning-point had at last been reached. Observation had previously shown that the curve of magnetic variations rises much more quickly to a maximum than it descends to a minimum, and so it has proved in the present instance. The great magnetic storm of October 31st, 1903, was heralded by considerable disturbance of the compass-needle on the previous night, though by 6 a.m. this seemed to have died down. Only an hour later, however, a magnetic storm commenced, such as had not been observed for more than 40 years or more. In the first and second phases, declination altered to and fro in waves of great amplitude, and the end of the oscillations in value of the horizontal component appears to have coincided both with the last great swing of the declination and with the end of the second phase of the storm (about 8 p.m.). The third phase was characterized by a gradual decrease in the anomalous magnetic conditions, and the storm came finally to an end between 5 and 6 a.m. on November 1st. Slight disturbances continued, however, for several days thereafter, and it was only on November 14th that the recording instruments showed absolute freedom from disturbance.

Complete tables and diagrams of the records are given by the author, and he then proceeds to compare the intensity of the magnetic storm with those which took place in 1847, 1859, 1872 and 1882. It would appear that the storm of 1859 approached most nearly that of 1903: the former was accompanied by nightly apparitions of *aurora borealis* from August 28th to September 3rd; and similarly in 1903 the "northern lights" were observed in many European localities about the time of the storm, also in North America, besides "southern lights" in Australia. The connection between maximum magnetic disturbance and a maximum sun-spot period is again made evident: the maximum sun-spot period was late in its arrival, coincidently with the lateness of the magnetic-storm period. On October 31st, a particularly large group of sun-spots was seen to travel across the central meridian of the sun. With regard to telegraph-wires, etc., those running underground were more affected by the storm than those carried on poles aboveground, and the disturbance was greater from north to south than from east to west, although there appear to have been exceptions to this rule in America. L. L. B.

VARIATION OF TERRESTRIAL MAGNETISM WITH ALTITUDE.

Sulla Variazione del Campo magnetico orizzontale terrestre coll' Altezza sul Livello del Mare. By A. Pochettino. *Atti della Reale Accademia dei Lincei*, 1904, *Rendiconti*, *series* 5, *vol. xiii.*, *pages* 96-101.

Dr. Schmidt has already shown that, although terrestrial magnetism is mainly due to influences seated within the globe itself, about one-fortieth part of the total magnetic force is probably derived from the electrical phenomena taking place in the atmosphere. But, according to Prof. Gauss' theory, the variation of the horizontal component of the earth's magnetism should be about 0·00001 for every 1,000 metres (3,280 feet) above sea-level.

In the summer of 1899, the author made a first series of comparative measurements in the mountain-group of the Gran Sasso d'Italia, and found a diminution in the horizontal component of 0·00005 for every 1,000 metres (3,280 feet) rise in altitude. Not regarding these measurements, however, as final, on account of certain disturbing conditions, he chose another district, in

the Rocciamelone group of the Graian Alps, where he should be able to record measurements at localities of very diverse altitude indeed, but not too far apart. These measurements were carried out in October, 1902, one observing-station being 900 metres (2,952 feet), and the other 3,400 metres (11,152 feet) above sea-level. The results obtained prove once again that the value of the horizontal component of the earth's magnetism, does decrease as the altitude above sea-level increases, and the author finds that the decrease approximates very closely to 0·00004. Dr. Sella had stated it to be 0·00002 in publishing the results of his investigations in 1896, while the figures arrived at by two Austrian investigators differ both from those of Dr. Sella and Dr. Pochettino: thus Dr. Kreil puts the decrease at 0·000147, and Dr. Liznar puts it at 0·00003. L. L. B.

THE PETROLEUM-INDUSTRY OF BAKU IN 1902.

Zur Lage der Naphta-Industrie in Baku im Jahre 1902. *By* P. J. Scharow *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 263-267.

Although the crisis which had depressed this industry was perceptibly passing away in the second half of 1902, the output for the whole year was less by 5·2 per cent. than even that of the unlucky year 1901; and the average prices for crude and refined oils were also lower. Some firms were compelled to close their wells down, rather than to continue working at a loss.

An analysis of the numerous statistical tables supplied by the author leads to the inference that the oil-bearing strata of the Sabuntshi district are showing unmistakable signs of gradual exhaustion, and the average depth to which borings had to be carried increased from 1,369 feet in 1901 to 1,426 feet in the following year. The contrary statement holds good of the comparatively-recently opened-up Bibi-Eibat district, where the average depth of the borings was less by 137 feet: owing, no doubt, to the immense productivity of certain oil-bearing strata, which continuously yield, despite extremely-active working, great fountains of naphtha. The average output of an artesian naphtha-well in 1902 was 5,217,000 puds (84,108 tons) as compared with 6,373,000 puds (102,744 tons) in the preceding year. The total quantity of oil got by pumping amounted to 542,094,852 puds (8,739,512 tons), or 31,062,776 puds (500,786 tons) less than in 1901. The number of bore-holes in use in 1902 was 1,840, being 84 fewer than in the previous year. Nevertheless, the export of lubricating-oil and oil-residues was more considerable in 1902 than ever before, though that of illuminating-oil and crude-oil was less by 9·6 per cent. than in 1901.

L. L. B.

THE GOLD-MINING INDUSTRY OF THE RUSSIAN EMPIRE.

Die staatliche Förderung der Goldindustrie in Russland. *By* B. Simmersbach. *Zeitschrift für das Berg-, Hütten- und Salinenwesen im preussischen Staate*, 1904, *vol. lii., B. Abhandlungen, pages* 491-493.

The continuous diminution in the annual output of placer-gold from 1,319,725 ounces in 1892 to 1,127,983 ounces in 1899, is largely attributed by the author to the vexatious legal enactments with which the Russian Government hedged round the industry until quite lately. In opening up a new gold-mine endless formalities had to be gone through, and even then

the miner was not allowed to have the free control of the output, or to so arrange matters as to diminish the cost of working. In addition, the taxes on the industry were very unequal in their incidence; wages were high, and stores were expensive, on account of the generally-considerable distance of the mines from the great centres of population; and the climatic conditions in such regions as Siberia and the Amur country are, of course, terribly severe.

A change of policy on the part of the Imperial Government found drastic expression in the law of March 12th, 1901, whereby the taxes on gold-mines were abolished and the free sale of placer-gold was authorized. Under the old *régime* a large portion of the gold-output had been secretly smuggled across the frontier into China, thus cheating the Russian Treasury of its dues, in defiance of penal enactments. In view of the primitive methods of mining, so primitive, indeed, even yet, that the rich placers of Siberia and the Urals may be spoken of as having been plundered rather than mined, the Government has decreed the free importation until 1909 of all machinery intended for use in the gold-industry. This concession is of great value for such mining-centres as lie anywhere within reasonable distance of a railway, but it will not go far towards helping the more remotely-situated mines in the heart of Siberia or the Urals. Potassium cyanide has also been placed on the list of free imports. As it is further recognized that the difficulties in the way of private prospecting on a large scale are enormous, the Government itself has undertaken a detailed scientific and economic survey of the gold-fields of Siberia, which will include the preparation of geological memoirs and maps. Moreover, a special committee has been appointed to draw up schemes directed to the further advancement of the gold-mining industry; it has already issued maps of gold-mines now being worked or capable of being worked, together with detailed statistics as to their wealth, and full information as to the most advantageous means of transport. All this activity is doubtless reflected in the increased output of placer-gold, which amounted for 1901 to 1,272,818 ounces. It may be noted, in conclusion, that this Russian gold averages 900 parts per 1,000 of fine gold: the cost of production varies enormously according to the district, but the further spread of regular methods of working will put an end to many anomalies. L. L. B.

PYRITES AND IRON-ORES OF SCANDINAVIA.

Über den Export von Schwefelkies und Eisenerz aus Norwegischen Häfen. By J. H. L. Vogt. *Zeitschrift für praktische Geologie*, 1904, *vol. xii., pages* 1-7, *with* 2 *diagrams in the text.*

The author points out that since pyrites began to be exported from Norway in 1860, the average annual export of that mineral has risen from 9,300 to 105,000 tons. Before long, the annual amount is expected to reach 150,000 tons, as measures are being taken to extend greatly the Sulitjelma mines in Northern Norway, and to open up new ones. More than half of the exported Norwegian pyrites is free from anything but a mere fraction per cent. of zinc, and so when the sulphur is roasted off it yields very good "purple ore." The mines that formerly worked pyrites containing a comparatively-high percentage of zinc-impurities are now abandoned. Moreover, in contradistinction to the Spanish and Portuguese pyrites, that of Norway is practically free from arsenic.

Still more important than the exports of pyrites from that northern region are, however, the exports of iron-ore, which began to make giant strides at the opening of the last decade of the nineteenth century. Turning first to Sweden, we are reminded that the ancient metallurgical industry of that country was based on the possession of iron-ores free from phosphorus. But the new export-industry derives its impetus from the formerly-untouched deposits of iron-ore containing an appreciable percentage of phosphorus. Some statistics and other particulars are given as to the Grängesberg, Gellivaara, Kiirunavaara and Luossavaara deposits. The amount of ore available in Northern Sweden is reckoned at 1,000,000,000 tons containing from 62 to 63 per cent. of iron. In Northern Norway, the most important deposits yet opened up are those of the Dunderland valley, within the Arctic circle, and a whole series of similar but smaller deposits are scattered along the coast between 65 degrees 50 minutes and 69 degrees 10 minutes of north latitude. The author considers that the mistrust expressed in Continental trade-periodicals as to the probable success of the Edison method of magnetic separation is unfounded: he has seen similar Swedish methods in operation, and they work smoothly and cheaply. Although iron-ore has been exported from Southern Norway to the extent of 50,000 tons or so *per annum*, no considerable development of the export from that part of the country need be looked for.

The Swedish exports of iron-ore have risen from 120,000 tons *per annum* in 1889 to 1,750,000 tons in 1901 and 1902. From Ofoten, in Norway, where exports began only in January, 1903, the export is soon expected to average 2,000,000 tons *per annum*, and the railway can furnish transport-facilities for 3,000,000 tons. Within a very few years the united annual export from Sweden and Norway will probably average 4,000,000 tons. In comparison with the Spanish ores, which contain a smaller percentage of iron, the Scandinavian will, in time, assume at least equal importance from the point of view of European industry. The Norwegian harbours, being free from ice, will send out more than the Swedish harbours on the Baltic: England and Scotland are likely to remain the principal customers for the Bessemer-ore; while the Thomas-ore is chiefly taken up by German buyers, and the more Germany takes of this ore the higher will wax the prosperity of the Norwegian harbour of Ofoten. L. L. B.

KLONDYKE GOLD-MINES, CANADA.

Gîtes aurifères du Klondike, Yukon, Canada. By J. M. Bel. *Comptes-rendus Mensuels des Réunions de la Société de l'Industrie Minérale*, 1904, *pages* 76-79.

The mean temperature of the region is 23° Fahr. The alluvial deposits are frozen down to the bed-rock, and mining is only carried on during the very short summer, when water can be obtained for treating the "dirt." The auriferous veins are not workable to profit. Copper-ores are being worked in the White Horse district, near to recently-discovered deposits of bituminous coal, probably of Carboniferous age. The alluvial gold is chiefly found in frozen gravels of Pliocene or Quaternary age, generally overlying the crystalline schists of the Klondyke series.

The Quaternary alluvia attain a thickness in the recent valleys varying from a few feet to 60 feet; and on the slopes and the hills they form terraces at a higher level than the present valleys, with thicknesses up to

150 feet. In the valley and terrace-deposits, the rich zone, which is alone remunerative, follows the ancient channels with a width that does not generally exceed 350 feet. The workable thickness varies from 3 to 7 feet, including about 1 foot of bed-rock, more or less altered and enriched by natural concentration and the action of running water. The gold, always found in grains, sometimes flattened, is deposited near the bed of the subjacent rock, and it appears to have been rolled for only a slight distance. The gold is accompanied by the usual minerals, including titanic iron and sometimes cassiterite.

The royalty to the state has been diminished from 10 to 2½ per cent. of the gold exported. The granular nature of the native gold permits of very simple treatment, by washing in very short "sluices," without mercury, although the absence of fall in the district and the obligation of leaving the water at the disposal of one's neighbours often necessitates the use of pumps.

In the Klondyke during 1902, the cost of extracting a cubic yard of dirt varied from 10s. to 15s. The gold-production of the region, which attained a value of £500,000 in 1897, increased gradually until it realized £4,600,000 in 1900, but fell to £2,540,000 in 1903, the decrease being attributed to the rapid exhaustion of the richer deposits. J. W. P.

THE MINING DISTRICT OF POTRERILLO, CHILE.

El Mineral de Potrerillo. *By* ENRIQUE KAEMPFFER. *Boletin de la Sociedad Nacional de Mineria*, 1903, *series* 3, *vol. xv.*, *pages* 408-415 *and* 1 *plate.*

This district lies in the south-eastern portion of the department of Chañaral (province of Atacama), some 54 miles distant from Pueblo Hundido, the present eastern terminus of the Chañaral State Railway. It includes the Hueso mountain-range, and the neighbouring massifs, at an average altitude of 10,440 feet above sea-level. The climate is that common to the Andine region, involving brusque changes of temperature and occasional snow-storms. Timber and water, if not exactly available on the spot, are to be obtained easily enough in the near neighbourhood of the mines.

The author visited about two dozen mines, and he mentions about a score of others which he had not the time to see. The ores are mainly carbonates and oxides of copper, slightly auriferous and argentiferous. Native copper is of comparatively rare occurrence. The gangue varies greatly in character and composition; and in some cases the ore can be separated from it with the greatest ease, while in other cases exactly the reverse statement applies. The ore-deposits are generally "bedded," occurring less commonly in the form of veins.

A table of assays is given, and one company worked between December 31st, 1899, and May 31st, 1903, a total of 14,564 tons, assaying on an average 14·94 per cent. [of metal]. The author considers that the conditions are favourable for erecting the necessary plant for treating the ores on the spot in the wet way. L. L. B.

METALLIFEROUS MINES OF NAICA, MEXICO.

Apuntes sobre el Mineral de Naica. *By* LEOPOLDO SALAZAR. *Memorias de la Sociedad cientifica "Antonio Alzate,"* 1903, *vol. xix.*, *pages* 71-83.

Naica lies some 33 miles north-west of La Cruz station on the Central Mexican Railway, in an immense arid plain, out of which rise a few small

hills. The construction of a good road for wheel-traffic, bringing the mines into direct communication with the railway, should offer no difficulty. As it is, a road communicates with the Conchos station, farther north, and a longer road with Santa Rosalía, the chief town of the district of Camargo, to which Naica belongs. The climate is, on the whole, cool, but the region is a desert which does not grow a stick of timber. Mines were worked there in the olden time, although not much trace of them remained at the period of the author's visit in 1899. Difficulties of water-supply account for the former abandonment of mining operations; but the face of things has changed completely within the last 4 years, and the district has now become one of the most important mining centres of the state of Chihuahua. The predominant rock of the Sierra de Naica is a compact grey limestone of Cretaceous age, containing lenticular cavities of comparatively-low dip (10 to 30 degrees) and of very irregular breadth, infilled with metalliferous ores, from which nearly-vertical metalliferous seams or veins run up to the surface; it is quite possible that similar ramifications extend from the main ore-bodies downward. Several assays made by the author show the ores to be chiefly silver-lead ores, in some cases auriferous and cupriferous, the percentage of lead varying from 40 to 60, and of silver from $\frac{1}{3}$ to nearly $1\frac{3}{4}$. L. L. B.

THE MINES OF THE PROVINCE OF ANGARAES, PERU.

La Minería en Angaraes. *By* W. A. Zumaita. *Boletín del Ministerio de Fomento*, 1903, *No.* 8, *pages* 62-67.

The writer, making an official report to the Peruvian Government, points out that to enumerate the number of abandoned mines in this province would be a wearisome task: at one time or another in the course of ages, several thousands have been worked there, but few were on any considerable scale. A list is given of half-a-dozen fairly-important copper, blende and lead-mines abandoned within recent years, and it is stated that the chief reasons why the mineral industry does not prosper in that remote province are:—(1) Difficulties of transport, obstructing both the export of ores and the introduction of machinery; and (2) the want of smelters for obtaining copper-silver mattes on the spot. If a smelting-works with reverberatory furnaces could be established, it would give the mineral industry of the whole province a fresh lease of life.

A catalogue is given of abandoned smelters and amalgamation-works, but there is at any rate one of the former still in active operation, at the San Pedro mine. The Sullac establishment, where the lixiviation-process was formerly carried on, is now being converted into an amalgamation-works.

Besides innumerable auriferous and argentiferous veins, there are in the Caruapata district and in the neighbourhood of Ingalmasi, abundant deposits of native sulphur. Coal, of middling quality, occurs on the Yanahututo estate and in the highlands of Pirca. In the Acobamba district, coal-seams yielding remarkably-little ash have been found, but the attempt to work them has been given up, as the mineral crumbles so easily that transport is difficult. In the neighbourhood of the coal are great "reefs" of perfectly pure iron-ore. Moreover, oxides and carbonates of copper and antimony-ores are abundant, and of widespread occurrence. So, too, are the deposits of silver-bearing zinc-blende and of gypsum. A thick vein of

orpiment and realgar occurs among the highlands of Yanahututo, and "native arsenic" is reported from Caruapata. In the neighbourhood of Julcani, there is a tungsten-deposit associated with gold, and there are abundant deposits of pyrolusite. Mercury and bismuth-ores have been found, but apparently not in payable quantity. L. L. B.

MINING IN THE PROVINCE OF HUALLANCA, PERU.

La Minería en Huallanca. *By* Estenio J. Pinzás *and* Feliciano Picón. *Boletín del Ministerio de Fomento*, 1903, *No.* 12, *pages* 37-53.

The city, which gives it name to the province, is situated at an altitude of 11,320 feet above sea-level, and two smelting-works are now in full activity there. Very brief descriptions are given of the various mines in the ravines of Capacog, Tucapag and Contaicocha; these apparently work metalliferous ores containing handsome proportions of silver and gold. In the Cerro de Huanzalá, argentiferous and auriferous copper-ores, in places associated with iron-pyrites, are worked.

Anthracite, often of unexceptionable quality, occurs in thick seams (3¼ to 6½ feet) among the sandstones of the Queropalca district, and extends over a considerable area. It is stated that "hundreds of millions of tons" of coal are in sight. At present four mines are working the mineral. Abundant seams of bituminous coal have been struck in the districts of El Cercado and Pachas.

Gold-placers are known to exist in many localities, and gold is washed in the dry season by the natives ("Indians") on a small scale.

Bituminous limestones "sweating petroleum" (?) have been recorded in two localities.

The roads appear to be in a lamentable condition, and the management of the mines generally is defective in technical knowledge and skill.

L. L. B.

THE CINNABAR OF HUANCAVELICA, PERU.

El Cinabrio de Huancavelica. *By* A. F. Umlauff. *Boletín del Cuerpo de Ingenieros de Minas del Perú*, 1904, *No.* 7, *pages* 1-62, *with* 16 *figures in the text and* 2 *plates.*

The first chapter of this memoir is devoted to a survey of the economic conditions affecting the output and market-price of mercury generally, which leads to the conclusion that there is no present prospect of any notable increase in the consumption of that metal, but on the contrary some probability that there will be a distinct diminution in the demand for it. The present annual import into Peru averages 30 tons, free of duty, but it is thought possible by some that the deposits about to be described may well render that country in the future independent of foreign supplies, nay, even convert Peru from an importer into an exporter of mercury.

The cinnabar-mines of Huancavelica have a lengthy history behind them, the Santa Barbara mine having been purchased by the Spanish Government as long ago as the year 1570. Mining operations, attended with more or less administrative mismanagement, incompetence and peculation, continued on the Santa Barbara property until 1785, when "great reforms" were introduced; and by the year 1800, the number of "managers" and superin-

tendents connected with that mine alone amounted to 70. The Spanish viceroys claimed that the Huancavelica ore-deposit was "the greatest wonder of the world," and they seem to have regarded it as the most considerable asset of the dependency over which they ruled. Its great importance lay, of course, in the utilization of the mercury for the amalgamation of the silver got from the innumerable mines worked during the period of the Spanish colonization. After the liberation of Peru from the Spanish yoke, various spasmodic attempts were made, at intervals of many years, to re-open the workings at Huancavelica, but up to the present time nothing has been done on a scale worth mentioning.

The city of Huancavelica lies in 12 degrees 53 minutes south latitude and 75 degrees 4 minutes west longitude of Greenwich, at a height of 12,438 feet above sea-level; the climate is fairly rigorous, abundant rains falling from December to April, and heavy frosts beginning in May. Mineral springs of medicinal value abound. On the south extend the ancient workings of the Santa Barbara and other mines: in none of these, opines the author, will it ever be practicable to resume mining operations, for these would prove dangerous as well as unduly expensive. Many parts of the old workings have collapsed, or are obstructed by falls of rock; and, apart from this, one is never certain in the area described, where one is going to come upon old workings or landslips. Consequently, a certain quantity of cinnabar is irrecoverable; but outcrops of the ore are recorded from eleven localities south and east of Huancavelica, many of which are untouched. The cinnabar appears in these to occur indifferently in limestone, sandstone, and conglomerate, occasionally in the form of veins. In the San Jerónimo or Quishura ridge, however, the cinnabar is found as the partial infilling of a fissure (10 to 13 feet broad) in a mighty mass of basalt. The occurrences of mercury-ore north of Huancavelica do not appear to be of much commercial importance.

The sandstones and limestones above-mentioned are shown, by the fossils (which the latter rocks especially contain in abundance), to be of Cretaceous age. The coarse conglomerates, largely made up of angular fragments, mantle over a considerable portion of the surface, and are evidently of post-Cretaceous age. Some shales are in places interbedded with the sandstones and limestones, and andesite-dykes and bosses (with which iron-pyrites is almost invariably associated) traverse the sedimentary Cretaceous rocks. In the basalt-ridge already mentioned, south-west of Huancavelica, the fissure-veins are mineralized with silver, lead and copper, as well as mercury. In the sandstones, the cinnabar is, on the whole, an impregnation-deposit; in the limestones, it appears to be the outcome of sublimation; and in the conglomerates, that of sedimentation. So it occurs in every form that can well be imagined: isolated granules, veinlets perpendicular to the bedding, lenticular masses, gash-veins, stockworks, pockets, etc. The cinnabar in the conglomerates really consists of particles surviving from the erosion and disintegration of the original matrix-rocks, and washed into their present position by the acid waters which continuously percolate through the conglomerates. The ore is manifestly of later formation than the sandstones and limestones which are its matrix, and is genetically associated with the volcanic phenomena of which the andesites and basalts are the silent witnesses.

Native mercury has been found on the river-banks and in the tributary glens in this area, and is evidently derived from the decomposition of portions of the cinnabar-deposits. Choice specimens of the cinnabar yield from 7 to 10 per cent. of the metal, while the average assay (taking all grades

together) is 2 per cent. Enormous waste-heaps remain from the old mines, but it is uncertain whether they would repay working.

With regard to fuel, the department of Huancavelica possesses abundant resources, in the shape of coal-seams, bituminous shales, peat-deposits, and growing timber (the last-named being also available for structural purposes). Very little exploration-work has been done on the coal-seams so far. Labour is easily obtainable locally, and is cheap; and many watercourses could be utilized for hydraulic power. From Huancavelica, the distance by road to Oroya railway-station, the present terminus of the line from Callao harbour, is 146½ miles; the distance to Ica, whence a railway runs to Pisco, another harbour on the Pacific seaboard, is about 186 miles, and the road is in many respects not so good. In an appendix, the author describes the 103 hand-specimens of rocks, fossils and minerals which he collected in the district and brought back with him. L. L. B.

USE OF CALCIUM CARBIDE AS AN EXPLOSIVE.

Etude sur le Carbure de Calcium employé comme Explosif dans les Travaux miniers. *By* M. P. S. Guédras. *Comptes-rendus hebdomadaires des Séances de l'Académie des Sciences*, 1904, *vol. cxxxix., pages* 1225-1226.

The author has made experiments, with the view of showing that this substance may be regarded as a possible substitute in mining operations for dynamite or gunpowder, and that it may be similarly used for military purposes. He first of all granulates the carbide, then loads it in a water-cartridge, and in a specially-shaped cavity of the cartridge introduces an electric fuse. A drill-hole being made in the rock in the usual fashion, the cartridge is thrust in, the remaining space is stemmed with wood, and the percussion-rod (which breaks through the thin partition that separates the water from the carbide) having been struck, an interval of 5 minutes is allowed for the evolution of the acetylene gas; then the cartridge is fired by electricity. It is found that the effect of the explosion is not to project masses of rock in every direction, but the rock in which the shot has been fired is easily brought down by the miner's pick. The quantity of calcium carbide used weighs about 1½ ounces, from which about ½ cubic foot of acetylene gas is evolved. L. L. B.

STORAGE OF NITRO-GLYCERINE EXPLOSIVES.

Essais de Congélation des Explosifs a Base de Nitro-glycérine. *By* Léon Saclier. *Comptes-rendus Mensuels des Réunions de la Société de l'Industrie Minérale*, 1904, *pages* 37-42, *and* 1 *plate*.

Mine-owners who have used nitro-glycerine explosives have experienced great difficulty in preventing their congelation, and also in providing for their storage. When first employed in French mines, these explosives were stored in surface-depôts, unwarmed, where they froze in winter; and it became necessary before using them to thaw them in a water-bath, which caused so many accidents that attempts were made to substitute underground for surface-depôts. In underground magazines, with constant temperature, the frozen explosive returned to its plastic state, and that which was stored at the temperature suitable for use retained all its good qualities, so that underground magazines constituted a step in advance,

while for 15 to 20 years accidents were avoided: but the explosion of the Aniche magazine caused the quantity of explosives stored in underground magazines to be limited to 2 cwts. (100 kilogrammes).

This limit of quantity in mines where the daily consumption varies from ½ to 1½ cwts., obliges the mine-owner to renew his supply daily, involving the daily carriage, handling, letting down, and storage of the explosives, in addition to which dynamite, which is stored underground in the frozen state, has not time to thaw before being used, so that the advantages of underground magazines are lost. This carriage and handling, with the absolute impossibility of thawing naturally, constitute a far greater danger than that which it is intended to avoid by the above-named limit of deposit; and the author hopes that a serious accident will not occur, to demonstrate the correctness of his opinion on the subject. It is therefore desirable that the question of storing dynamite in underground magazines should be thoroughly thrashed out, with a view to permitting the storage of 4 cwts. (200 kilogrammes) of explosives in such magazines, so that their thawing may take place naturally, thus avoiding dangerous carriage and handling.

J. W. P.

DAMMING OFF WATER BY CEMENT-GROUTING OF THE NATURAL WATER-CHANNELS.

Die Wasserabdämmung beim Abteufen des Pöhlauer Schachtes der Gewerkschaft Morgenstern in Reinsdorf (in Sachsen) durch Versteinung der natürlichen Wasseradern. By Alfred Wiede. *Berg- und Hüttenmännisches Jahrbuch der k.k. Bergakademien zu Leoben und Přibram und der königlich ungarischen Bergakademie zu Schemnitz*, 1902, *vol. l., pages* 173-182; *and Jahrbuch für das Berg- und Hüttenwesen im Königreiche Sachsen*, 1901, *pages* 66-73, *and* 2 *plates.*

The Morgenstern Colliery Company started, on September 3rd, 1900, sinking a new shaft at Pöhlau, near Reinsdorf, in Saxony. This shaft, intended chiefly for ventilating purposes and for taking the miners up and down the pit, was put down about the centre of a newly opened-up coal-district, immediately north of the high road from Zwickau to Liechtenstein, on the summit of the Pöhlau ridge, which strikes east and west. The shaft was designed to be circular, 13½ feet in internal diameter. The uppermost strata were found to consist of a greyish-yellow impermeable loam, passing deeper down to a dark-grey, containing some rolled pebbles of brown coal and many chalk-covered flint-nodules. At the depth of 72 feet, weathered Rothliegende conglomerate was struck, but soon the unweathered tough rock was got into, and walling of the shaft with hard-burnt bricks was begun. Meanwhile, as they went down through the conglomerates, water began to come in, the flow varying from 3 to 50 gallons per minute. Iron tubing was inserted in the walling at the points where the water-feeders were observed, and the water was led down to a sump whence it was pumped out of the pit by an electrically-worked differential plunger-pump, the maximum efficiency of which was reckoned at 132 gallons per minute. The possibility of a larger flow was not foreseen, as nothing approaching that had been experienced in the other shafts of the Morgenstern colliery. But, at a depth of 206 feet, another feeder was met with, the water from this alone averaging 132 gallons per minute, and as the pumping-engine was already dealing with 44 gallons a minute from points nearer the surface, it could no longer suffice to meet all the calls made upon it.

Under these circumstances, the engineers resolved to see whether the inflow of water could not be stopped by forcing cement-grouting under pressure into the natural water-channels as far in as possible, the "grouting," as it hardened, forming an impenetrable stone-filling of these same chanels. The subterranean watercourses were traced parallel to the stratification with a northerly dip of 8 degrees, in a soft sandy layer intercalated among the conglomerates; at the three main points of inflow, grouting was pumped in (to the amount of 292 bushels of dry cement). The shaft was then walled round, and through the walling more grouting was pumped into the strata. The operation was completely successful, and when, on a still worse feeder at a depth of 270 feet being encountered, the process was repeated, equally-satisfactory results were obtained. For fairly-broad fissures a mixture of a volume of dry cement with an equal volume of water was used; with narrow fissures it was found advisable to dilute this rather more, on account of the increased resistance opposed by friction to the flow of the mixture.

The process does not involve any considerable expenditure of time or money. It is not yet possible to say whether, under such circumstances, pumping operations may with safety be completely abandoned, but at all events they may be reduced to a minimum. Many springs in the village of Pöhlau, which had dried up during the inflow of water into the above-described shaft, began immediately to flow again, after the petrification of the subterranean water-channels had been successfully accomplished.

L. L. B.

COLLAPSE OF A SHAFT AT GLADBECK, WESTPHALIA.

Der Einsturz des im Abteufen begriffenen Schachtes IV der Zeche Graf Moltke am 16. März 1903. By — FREUND. *Zeitschrift für das Berg-, Hütten- und Salinenwesen im Preussischen Staate*, 1904, *vol. lii., pages* 195-199.

The Nordstern Colliery Company had been instructed by the Royal Mining Bureau at Dortmund, to sink a new shaft at their Graf Moltke pit, near Gladbeck, in order to improve the ventilation of the mine, and so sinking was begun in November, 1902. A depth of 259 feet had been reached when, on March 16th, 1903, the lower portion of the shaft fell in, and an overman and 6 workmen were killed.

The condition of the strata having been ascertained when sinking the closely-adjacent shaft, No. 3, in 1900-1901, no great difficulties were expected; and in fact the 26 feet of superficial deposits were sunk through to the comparatively-dry Emscher Marl without any hitch. In this the total inflow of water was found to amount to 132 gallons per minute; it was dealt with by means of a pulsometer-pump, and there was every hope of reaching the Coal-measures at a depth of 890 feet or so.

The disaster was preceded by the appearance of two almost vertical cracks in the strata, then a wedge of rock, 6½ feet broad, fell forward and exerted a very noticeable pressure on the provisional timbering. Thereafter, small masses of rock began to break down continually as the tubbing was being carried on, the timbering cracked ominously, and though none of these signs escaped the attention of the overmen who were in charge of the work, no precautionary measures were taken, for these overmen were anxious to get the work over as quickly as possible, apparently at any risk. Walling had been built to a height of about 50 feet, when at 6 a.m. on March 16th,

1903, the cracking of the upper timbering became so loud and continuous as to cause genuine alarm, and the men engaged in the sinking began to clamber up towards the cage. But before they could reach it, the timbering gave way, the strata between the wall and the wedging-ring fell in and smashed down the staging, and several men were hurled, with the flying débris, to the bottom. All lamps went out, and a continuous shower of fragments of marl began, under which the victims of the disaster were subsequently found buried. One of the two overmen, to whose neglect the accident was due, perished in it, and the other fled from the district, with warrants out against him. Stringent regulations have been drafted by the colliery-officials to prevent the recurrence of a similar disaster in future sinking-operations.

At the Mónopol colliery in Westphalia, an accident, resembling in many respects that just described, occurred in October, 1893, and the conclusion is drawn that in sinking through the soft, crackly Emscher Marl, special attention must be given to the strengthening of the walls of the shaft.

L. L. B.

ROCK-THRUSTS IN WESTPHALIAN COLLIERIES.

Die in den letzten Jahren auf Steinkohlengruben des Oberbergamtsbezirkes Dortmund vorgekommenen Gebirgs-stösse und die hierdurch herbeigeführten Unfälle. By — Dill. *Zeitschrift für das Berg-, Hütten- und Salinenwesen im Preussischen Staate*, 1903, *vol. li., pages* 439-466, *with* 7 *figures in the text and* 3 *plates.*

For some time past, the Dortmund mining-district has had to record almost every year a number of accidents due to so-called thrust-movements in the rocks. Fortunately, the victims claimed by these accidents are far fewer in number than in the case of ordinary falls of stone and coal. Such accidents deserve, however, investigation, as in many instances it is the actual progress of mining operations which brings them about, by gradual destruction of the natural support of a given mass of rock.

In the Ruhr coal-field, the name of rock-thrust (*gebirgs-stoss* or *gebirgs-schlag*) has been applied to a hitherto unexplained form of earthquake, apparently started by sudden release of tension in a rock-mass, and occurring more especially when safety-pillars are being removed. With a report like the boom of artillery and a violent gust of air, the coal-face is torn asunder, and the coal is shot out in fragments along the levels: the floor buckles up, the timbering is knocked over (though not shattered), and every object near the site of the accident is whirled along or struck down by the falling masses of rock. So sudden and violent a phenomenon as this generally implies death for any workman near the spot. Subsequent investigation sometimes reveals the presence of a considerable quantity of fire-damp and shows the roof to be generally uninjured. Above-bank, these rock-thrusts, so far as they make themselves felt, resemble an ordinary earthquake. Curiously enough, they usually occur in those parts of the workings which are in the immediate neighbourhood of the goaf, or form a sort of island in the midst of it, or where considerable activity in mining operations has been attended by partial or complete neglect of packing, and where the seams have an unusually-sound roof, by no means liable to crack.

The first three accidents of this kind described by the author occurred in the Frederick-the-Great pit, at Herne, in 1896 and 1897. In two out of the

three, a man was killed in each case, and in the third a hewer was disabled for life. Packing, previously considered unnecessary, was afterwards resorted to. An accumulation of fire-damp was reported in one case.

Then, two such accidents took place at the Victor pit, at Rauxel, in 1898 and 1899. Here the same Sonnenschein seam was being worked, and under the same conditions, as at the first-mentioned colliery, but in the eastern district of the workings packing was customary. Not so in the western district, where the two accidents occurred. In both cases, some men were badly injured. The considerable evolution of fire-damp which followed upon the second accident may not have been a mere invasion of gas from the goaf, but may have arisen from the sudden crushing and spreading out of great masses of coal (characteristic of a rock-thrust) which would liberate the gases occluded in the pores of the mineral. Precautions were afterwards taken, in the way of safety-pillars, timber-supports, and packing where necessary.

The rock-thrusts, which took place at the Shamrock I. and II. collieries, at Herne, in 1897 and 1899, differed from those so far mentioned, in that their effects were especially marked above-bank and not so much below. Here again, they seem to have been due to the working-away of the Sonnenschein seam. The shock felt in the town of Herne, in 1897, was so violent that the affrighted inhabitants ran out of their houses into the streets, and the thunderous rumbling which accompanied the earthquake heightened the general feeling of insecurity and terror. Walls were fissured, chimneys and roof-slates came crashing down, and the effects were felt over an area which would be represented by a circle with a diameter of $2\frac{1}{4}$ miles. Packing, in that district of the colliery which was mainly affected, had only been begun a short time before the accident here described.

The most destructive in its effects of all the rock-thrusts, so far recorded in Westphalian collieries, was that which took place on July 14th, 1899, at the Recklinghausen I. colliery, at Bruch. Many of the workings in the Sonnenschein seam were totally or partly destroyed, 4 workmen were killed, and a number of others more or less seriously injured. Aboveground, the shock was felt throughout the parishes of Bruch, Herne, Recklinghausen, Gelsenkirchen, Bochum, Castrop, etc., in fact over an area which would be covered by a circle not less than $6\frac{1}{4}$ miles in diameter. In the pleistoseismic portion of this area, from 100 to 150 separate buildings suffered damage. Full details are given of the destruction wrought within the colliery itself. Special regulations were afterwards drawn up, as to the precautions to be observed in future in working the Sonnenschein seam there and elsewhere in the Herne district. No further rock-thrusts have been recorded in that particular district since then.

On March 16th, 1900, at the Steingott colliery, Laura shaft, near Altendorf, a sudden rock-thrust, again in the Sonnenschein seam, cost two workmen their lives.

The author then describes similar accidents which occurred in 1902 and 1903, at collieries near Eppendorf and Hugo respectively, in levels where the Finefrau and Bismarck seams are worked. These were also attended with loss of life. Stress is again laid on the partial or total absence of packing.

The possible causes of such rock-thrusts are discussed at considerable length, but although the author evidently believes them to be the indirect result of very active mining operations, he does not commit himself definitely to an hypothesis which would exclude other possible causes. L. L. B.

WATER-PACKING OF SEAMS.

Bericht über das Schlammversatzverfahren auf den oberschlesischen Bergwerken sowie auf der Zeche Sälzer-Neuack bei Essen.—Erörterungen über die mögliche Anwendbarkeit dieses Verfahrens im Ruhrkohlenbezirke unter besonderer Berücksichtigung der Verhältnisse auf Schachtanlage Alma. By KARL MÜLLER AND HUSSMANN. *Glückauf*, 1903, *vol. xxxix., pages* 927-941, *with* 18 *figures in the text and* 1 *plate.*

The authors describe a method of filling goaves in coal-mines by fine sediment carried into place by water. The working of thick seams, without stowing the goaf, is attended by great damage to the surface, the loss of up to 35 per cent. of the coal, and damage to adjacent seams. The cost is also high, due chiefly to the large size and quantity of timber needed. Moreover, the height of the working-places is a danger to the workmen. Stowing the goaf has not been much adopted, as it costs too much to bring material from bank, and the material having been got into the mine, it will not gravitate into place when the inclination of the seam is only from 10 to 15 degrees. The sluicing system was introduced 2 years ago at the Kattowitz and Myslowitz collieries, and has been found cheaper than stowing by hand. Whether the sand, etc., will give permanent support, time alone will show. But, up to the present, although the surface-level has been slightly lowered, the adjacent seams have not been damaged by settlement.

Briefly, the system is as follows:—The goaf is packed by some fine material, such as sand, breeze, cinders, etc., carried into place through pipes by a flow of water. The proportion of water to material is from 2 to 1 part to equal parts, according to the nature of the material used. The mixture is made either at bank or near the goaf to be filled. When the material has been deposited, the water is drained off, filtered and collected. It is then pumped to bank, and in some cases used over again.

Myslowitz Pit.—Three seams of coal are being worked, from 10 to 60 feet thick. Near one of the shafts there is a large sand-bed upon the surface, from which the sluicing material is taken. Tip-wagons are filled by a sand-dredger, and taken by an electric locomotive to the shaft. The sand is poured down into a recess, which has been formed in the shaft-side, on to a grid. Above this grid, a pipe-nozzle is fixed, which sprays water on to the sand. Below the grid is a funnel to catch the mixture of sand and water, and convey it into the range of pipes. The mixture used here is 1½ parts of water to 1 part of sand, but the sand is very clean and free from clay. This leads them to hope to manage with an equal parts mixture. The pipes used are 20 feet (6 metres) long, 6·61 inches (168 millimetres) in diameter and 0·24 inch (6 millimetres) thick. The pipes convey the sluicings 300 feet (90 metres) vertically and 2,000 feet (600 metres) along the level underground. The pipes soon wear out, especially on the under side, but they are turned four times, through a quarter-arc each time, and last from 2 to 2½ years. They are best placed on the ground to facilitate turning, and all T pieces and bends should be made thickest on the outer side of the bend, as they wear most there, lasting only 3 or 4 months. To overcome stoppages, short pipes are inserted. These can be readily taken out, and give convenient access. The range is always flushed before stopping, except on the steep lengths. There is telephone-communication between the chief valves underground and the mixing-station at bank.

The lower seam, 36 feet (11 metres) thick, is won by pairs of levels; the

space between is cut up into pillars, which are taken out one by one, beginning with the lowest. As soon as a pillar is taken out, the empty space left is dammed off by timber, caulked with dried horse-dung, and the sluicings turned on. When the space is filled, the sluicings are turned off, and the water drained away, leaving a solid pack. The water, while flowing along to the shaft through a deep level 3,300 feet (1,000 metres) long, deposits any fine dirt held by it, and arrives at the shaft clean enough to be easily pumped. These levels are cleaned every 3 months.

The timber used, while taking out the pillars, is not drawn before sluicing the goaf, but less is put in than when filling the goaf with stone by hand. The timber for the dams is all drawn and used again. By this system, barrier-pillars to protect the temporary incline-banks are not needed to such an extent, and more coal can be got from each district.

Ferdinand Pit.—The sand used here is not so clean, and requires a slightly-different form of nozzle and mixing-tray. The proportion is 2 parts of water to 1 part of sand. The surface here is built over, and has to be supported. The seam is 8·2 feet (2½ metres) thick, and lies at an angle of 15 degrees to the horizontal. The pillars are formed 40 feet by 50 feet (12 by 15 metres), and the coal is taken from them by lifts of 26 to 33 feet (8 to 10 metres). All the coal is extracted. The timber in the brokens is lost, but the timber forming the dams is regained. The drain-water is cleaned, by allowing it to settle in a standage. The clay in the water seems to have a cleaning action.

Alfred Shaft, Hohenlohe.—At this colliery, a bore-hole 19·7 inches (500 millimetres) in diameter and 100 feet (30 metres) deep is used. The dry sand is poured down this hole into the mine, where it is mixed with the water. The hole is only walled at the top and partly piped, but it has never been stopped. There is nothing else differing from the previously mentioned arrangements.

Arnold Shaft, Borsig Works.—The seams here are flat, and the water is forced through the pipes under a pressure of 5 atmospheres.

Concordia Pit.—The mixture used here is 1½ parts of water to 1 part of breeze. This kind of sluicing is expected to squeeze more in the goaf, and takes four weeks to become solid, but the method has not been long enough on trial to give definite results. The breeze gives off fumes when first put in place, and is apt to give the men headaches, if the ventilation is at all slack.

Sälzer-Neuack-Krupp Colliery.—Here again the surface has to be supported, it being built over by Messrs. Krupp's works. The mixture used is 2 parts of water to 1 part of material. The pillars are made 60 to 66 feet (18 to 20 metres) long, and removed by 10 feet (3 metres) lifts. The sand is taken down the pit dry, after being screened through a mesh of 3·15 inches (80 millimetres) and over a mesh of 1·18 inches (30 millimetres). The sluicings shrink about 10 per cent., so that the goaf is only filled 90 per cent. The cost of hand-stowing was 1s. 8d. (1·65 marks) per ton. The cost of water-packing, less the costs of the pipes and pumping is 9·6d. (0·80 mark) per ton. The estimate for these last items is 2·4d. (0·20 mark), which makes the total cost of water-packing the goaf 1s. (1·00 mark) per ton. But this cost could be reduced, if the mixing was done at bank instead of in the pit.

The writer discusses the feasibility of adopting this system in the Ruhr coal-field. He is of opinion that it cannot be generally adopted, but might be used in cases where special support is required. No sand is available, but some collieries have washeries, which might provide suitable material. The seams are inclined up to 50 degrees, which will make the pressure on the dams very great. A suggestion is made that a trial could be made in the Matthew seam of the Alma pit: and details of the requirements are given, including an estimate of the probable cost per ton. C. H. M.

SUBSIDENCES DUE TO SALT-WORKINGS IN FRENCH LORRAINE.

Note sur les Affaissements produits en Meurthe-et-Moselle par l'Exploitation du Sel. By L. Bailly. *Annales des Mines*, 1904, *series* 10, *vol. v., pages* 403-494, *with* 14 *figures in the text and* 3 *plates.*

In the department of Meurthe-et-Moselle, during the last 30, and more especially during the last 10, years, phenomena, remotely comparable with those that are so well known in the Cheshire salt-field, but on a much smaller scale, have made their appearance, and they seem likely to become still more frequent as time goes on. In what remains to France of Lorraine, the Middle Keuper salt-belt extends uninterruptedly for about 19 miles from Tonnoy to the frontier, with a breadth of over 9 miles from Rosières-aux-Salines to Nancy: the mining concessions taken out, so far, cover little more than a third of the area. The thickness of the salt-deposit varies between 33 and 230 feet; it is said to constitute one of the finest deposits of the kind in the whole world, and to be "ten times richer than those of Cheshire." For various reasons, the western limits of the field are unknown, but the Madon valley on the south-west might repay exploration-work. The rock-salt lies deeper down (300 feet or more below ground) than in Cheshire, is consequently better protected from the action of surface-waters, and is not overlain (except in a few instances) by a natural brine-lake, as is so often the case in the above-mentioned English county.

A short history is given of the salt-industry in Lorraine; and the author then remarks that his investigations do not apply to the actual rock-salt mines of Rosières-Varangéville, St. Nicolas and St. Laurent, which a recent Government enquiry has shown to be in no way concerned with any important subsidence in the area since 1873. The output of rock-salt, mined as such, in French Lorraine averages 100,000 tons yearly, while that extracted in the form of brine averages 450,000 tons *per annum*. The author then deals with the method of working by "dissolution-chambers"; where no natural brine-lake covers the salt, fresh water is introduced from the surface by means of pipes, and after a time a cavity of sufficient dimensions is formed to allow of regular brine-pumping for several hours daily. On account of the different densities of the water according to its more or less complete saturation with salt, these cavities tend to enlarge asymmetrically, extending more to the rise than to the dip of the strata; and in plan they form roughly an ellipse, of which the major axis trends parallel with the dip. The intervention of marly bands, even when saliferous, constitutes a great obstacle to the enlargement downward of the "dissolution-chambers." Nevertheless, the soft Keuper Marls, which form the roof of the salt-deposits, crumble away rapidly on contact with water, with frequently-resulting damage to the bore-holes and the pumping-apparatus. With the slow subsidences, actual or possible, that are traceable to the natural brine-lakes

of the Sanon area, the author does not concern himself; but to the dip of that area, where the Middle Keuper sinks below the very compact dolomites of the Upper Keuper, and these in turn are succeeded by the Infra-Liassic grits and the Sinemurian limestones, lies the valley where the only rapid subsidences so far recorded in the region have occurred. One took place at Ars-sur-Meurthe in 1876, another at St. Nicolas (only a third of a mile away) in 1879: elsewhere in the Meurthe valley there have been subterranean landslips, but none the effect of which has been evident at the surface.

The third chapter of the memoir is devoted to the workings connected with the natural underground brine-lakes of Dombasle and Einville, and to the subsidences which energetic brine-pumping has brought about in that district. The actual damage done to buildings, roads, canals and railways does not seem, however, to have been very great.

The fourth chapter deals with preventive and curative measures, some decreed by the French Government on expert advice, others suggested for future use. On the whole, the subsidences observed in Meurthe-et-Moselle bear no sort of comparison, in regard to their destructive effects, with those of Cheshire; in England it has been found necessary to invoke the aid of the "heavy Parliamentary traction-engine." The French engineers hope to avoid that necessity in their own case, by means of friendly negotiation between the interested parties. Meanwhile, they will avail themselves to the full of the experience so dearly bought in Cheshire. The strict methodizing of the pumping operations, involving an unsleeping control of that "blind and fickle mining-tool—water," appears to furnish the key to most of the difficulties connected with the subject.

L. L. B.

KARLIK REGISTERING SPEED-INDICATOR FOR WINDING-ENGINES.

Tachymètre Enregistreur Karlik. *By* **H. Kuss.** *Comptes-rendus Mensuels des Réunions de la Société de l'Industrie Minérale*, 1904, *pages* 35-36, *and* 1 *plate.*

Thanks to its simplicity, the Karlik tachymeter has rapidly come into general use. This instrument keeps a rapid and stringent check upon the working of winding-engines and the attention of the enginemen. The graphic diagrams show clearly the difference in speed for winding coal and that for men. Each caging operation is truly registered; and even the raising of the cage the height of one deck to another is exactly indicated. Every stoppage in winding, any slackening of speed and any excess of speed, is immediately put on record. In a well-regulated mine, manuscript notes will explain, as far as possible, any apparent anomaly; and the manager is able to check, day by day, by merely examining the cards, which are very clear and easily handled, all particulars of the winding. J. W. P.

GUIBAL FAN WITH COLLECTING VOLUTE.

Résultats d'Expériences sur un Ventilateur Guibal à Volute collectrice, établi au Siège No. 2 des Charbonnages de Fontaine-l'Evêque. *By* **E. Lagage.** *Publications de la Société des Ingénieurs sortis de l'Ecole Provinciale d'Industrie et des Mines du Hainaut*, 1904, *series* 3, *vol. xiii., pages* 106-113, *and* 1 *plate.*

Owing to the low mechanical efficiency of the existing fan and the air-volume having become insufficient, it was determined to erect a Guibal fan,

21 feet (6·4 metres) in diameter, 5·9 feet (1·8 metres) wide, with an inlet 8·85 feet (2·7 metres) in diameter and a volute collecting case, making 107 revolutions per minute, driven by a belt from an engine of 110 horsepower. As the shutter of the ordinary Guibal fan had been retained, notwithstanding the volute form of the case, experimental trials were made for determining its most favourable position, with the result that, for equal speeds, the largest volume was obtained when the shutter was raised 15·74 inches (40 centimetres).

The tests for efficiency, often repeated, with the same results, justify the conclusion that the Guibal fan thus modified can bear comparison with the best ventilators, as regards both efficiency and water-gauge. It was found that, when the equivalent orifice diminished, the efficiency diminished appreciably, while the water-gauge varied but slightly. These results prove that the Guibal fan is specially suitable for mines with large orifices; but it does not follow that this type is not also suitable for mines with small orifices. All that is required is to fix the dimensions of the fan in accordance with the orifice under consideration. J. W. P.

IMPROVED VENTILATION THROUGH SINKING A THIRD SHAFT.

Note sur l'Amélioration d'Aérage obtenue au Siège No. 1 de la Société des Mines de Liévin par la Création d'un Puits spécial de Retour d'air. By — MORIN. *Comptes-rendus Mensuels des Réunions de la Société de l'Industrie Minérale*, 1904, *pages* 45-48, *and* 2 *plates.*

The workings of No. 1 pit, Liévin colliery, were ventilated by No. 1 or the upcast pit and No. 1 *bis* or the downcast pit. The former was provided with a Guibal fan, 29·53 feet (9 metres) in diameter, and a second in reserve having a single inlet, 9·84 feet (3 metres) in diameter, running normally at 60 revolutions per minute and delivering 1,942 cubic feet (55 cubic metres) per second with a water-gauge of 2·36 inches (60 millimetres), the equivalent orifice being about 30 square feet (2·8 square metres).

With a daily output of 1,250 tons, the fire-damp content in the main return-airway was 0·4 per cent. The content in the most highly charged return-airway did not as a rule exceed 1 per cent., but that of several return-airways in the upper levels, which ventilated old workings, attained 1·2 per cent. generally and 1·5 per cent., or even 1·6 per cent. with a low barometer. The enlargement of the numerous return-airways, however, did not appear capable of affording any appreciable improvement; the increase of sectional area, long and costly to carry out, no longer producing sufficient increase in the ventilation; and, in some cases, owing to the large sectional area, the speed became insufficient to carry away the fire-damp issuing from old workings.

Accordingly, in 1897, further experiments were undertaken to determine the resistance due to the shafts and the workings, with the following approximate results:—Out of 2·05 inches (52 millimetres) of water-gauge produced by the fan at No. 2 shaft, extracting about 1,836 cubic feet (52 cubic metres) per minute, only 0·87 inch (22 millimetres) was due to the resistance of the workings, so that the remaining 1·18 inches (30 millimetres) represented the resistance of the shafts. The tubbing of No. 1 *bis* pit, 12 feet (3·65 metres) in diameter, having a travelling compartment, had a resistance of 0·59 inch (15 millimetres) over a height of 312 feet (95 metres); the timber tubbing of No. 1 pit, 13·12 feet (4 metres) in diameter, also having a travelling compartment, and in addition compressed-air and water pipes, only absorbed 0·22 inch (from 5 to 6 millimetres) and the remainder, 0·39 inch (10 millimetres), represented

the resistance of the walled portion, about 1,640 feet (500 metres) of a pit 14·76 feet (4·5 metres) in diameter, so that more than 60 per cent. of the total water-gauge was absorbed by the shafts. The resistance caused by the tubbing of No. 1 *bis* pit showed clearly the disadvantage of a small sectional area, and demonstrated the impossibility of improving the ventilation of No. 1 pit under the existing conditions; also that the improvement could only be obtained by widening the shafts, or sinking a third shaft of large sectional area: and this last solution was evidently the most rational, while being the only practical one.

No. 1 *ter* pit, used as an upcast-shaft, should afford, in addition to the improvement in ventilation due to its sectional area, the advantage of suppressing variations in the water-gauge and the leakage of air at the valves on the passage of the cages, while making No. 1 a downcast-pit, a very favourable state of things in the event of a fire-damp explosion or underground fire. The sectional area of the new shaft was made equal to that of the other two together, namely, 19·68 feet (6 metres) in diameter, both of these latter becoming downcast-shafts. The same fans were employed at the new shaft, with a single modification, namely, that the inlet was increased to 18 feet (5·5 metres) in diameter; and the same engine was used: the lower water-gauge being set off by the increased volume. The new shaft, brought into operation on January 1st, 1903, delivered 3,287 cubic feet (93·879 cubic metres) per second at a fan-speed of 55 revolutions per minute with 1·58 inches (40 millimetres) of water-gauge. The fire-damp content of the main return-airway is 0·2 per cent., and that of the most highly charged 0·8 per cent., while the equivalent orifice is 59 square feet (5·5 square metres).

Curves representing the resistances, measured in accordance with the different volumes in the three shafts, show at once the necessity of a third shaft for obtaining large volumes at great depths. Calculating these resistances for a depth of 3,280 feet (1,000 metres), leads approximately to a total water-gauge of 4·72 inches (120 millimetres) for ventilation with two shafts, but only 0·79 inch (20 millimetres) for one with three shafts. The advantage of the third shaft is also seen for smaller volumes; and especially as it would only have required, for taking off 1,942 cubic feet (55 cubic metres), a water-gauge of 0·55 inch (14 millimetres), while the work of the fan, which was formerly 44 horsepower, would have been reduced to one-fourth of that power. A saving would therefore have been effected of 33 horsepower or of 70 steam horsepower, with an efficiency of 45 to 50 per cent., which roughly represents the interest on the capital expended, about £32,000 (800,000 francs). In addition to the daily saving effected by the diminished resistance of the air, if it be considered that the new shaft permits of increasing the output to 475,000 tons without diminishing the safety, it will be seen that the proportion per ton of the expense incurred is less than that which would have been involved by a new plant. J.W.P.

EXPLOSIONS IN PRUSSIAN COLLIERIES DURING 1902 AND 1903.

(1) *Mittheilungen über einige der bemerkenswerthesten Explosionen beim Preussischen Steinkohlenbergbau im Jahre 1902.* Official. *Zeitschrift für das Berg-, Hütten- und Salinenwesen im Preussischen Staate* 1903, *vol. li., Abhandlungen, pages* 421-431, *with* 2 *figures in the text and* 2 *plates.*

On February 13th, 1902, at 12·15 p.m., a coal-dust explosion took place in the third level, working No. 2 seam, in the Königsborn pit, near Heeren,

Dortmund. Of the 4 victims of the explosion, all more or less badly burnt, 2 died after they had been brought to bank. No. 2 seam is about 4 feet thick, dips to the south 70 degrees, has a roof and floor of fairly-compact shale, and gives off extremely-little fire-damp. On the other hand, it yields an enormous amount of dust; and, in view of this, the precautions prescribed by the Government ordinance of December 12th, 1900, were observed throughout the pit: these precautions, of course, included systematic watering. No dynamic effects of the explosion, such as damage to the timbering or the spray-pipe system were observed; but a thick layer of fine coal-dust was traced for some distance upon every exposed surface. A shot, for the purpose of bringing down obstructive masses of stone and coal, had been fired with two cartridges of rock-dahmenite, and the disaster followed immediately thereupon, contrary to all previous experience with that safety-explosive. It would seem, however, that there is more than a suspicion that some dynamite had been surreptitiously mixed with the charge by the shot-firers, in contravention of the regulations. Fire-damp appears to have played no part in the matter at all.

On Tuesday, July 29th, 1902, at 12·30 p.m. a fire-damp explosion took place at the Government colliery of Camphausen, near Saarbrücken, whereby 14 persons were injured, 6 of them mortally. It occurred in the second level, working No. 3 seam, the lower portion of which is there about 5 feet thick, and separated by a parting, of variable thickness, from an upper layer of coal 2½ feet thick. From fissures in the strata evolution of gas had been noticed at rare intervals; but an examination of that portion of the pit where the explosion took place, carried out only 2½ hours before the disaster, that is, at 10 a.m., failed to reveal a trace of gas. The dynamic effects of the explosion appear to have been inconsiderable: crusts and beads of coke were traceable in some places, and a brattice or two were torn down. Coal-dust played a subordinate part in the disaster, the immediate cause of which has not been ascertained with certainty. It would seem, however, that while one man was engaged in watering a particular working-place, his mate, who was meanwhile resting, had hung up his lamp near a fissure in the roof, and a sudden unnoticed evolution of gas may have brought the inner gauze to incandescence (of which there is evidence). This being noticed, the man may, in his haste to remove the lamp, have dropped it, and the explosion will have arisen from the flame, which was then burning between the inner and the outer gauze, striking through.

On Saturday, August 30th, 1902, at 10 p.m., an explosion took place above bank in the boiler-house of Anselm II. shaft of the Hutschin collieries, at Petrzkowitz, Ratibor, Silesia, whereby a fireman was killed. This shaft serves as an upcast for Anselm I. shaft, which latter is a downcast and is used for haulage-purposes; Anselm II. shaft is provided with a Witkowitz fan, which can deal with 122,500 cubic feet of air per minute, and this had been stopped at 6 a.m., and the boiler-fires drawn for the purpose of repairs. No one had been left down the pit. Several masons and the above-mentioned fireman had been busied all day in repairing the foundations of the fan-engine, and when darkness set in they used naked lights. The above-mentioned fireman went with one of these into the boiler-house, and a few minutes later a tremendous concussion took place, and the fireman rushed out with his clothes all aflame. About a ¼ hour afterwards a dull thud was heard coming from the pit, but this second explosion produced no flames discernible at the surface. In the pumping-engine room,

windows were shattered and doors burst in; the latter caught fire, as did also the erections at the pit-head itself. An investigation, made the following day, showed that the dynamic effects of the explosion were traceable especially in the second, and down to the third, level of the pit. It is presumed that the stoppage of the fan must have caused a complete cessation of the circulation of air-currents in the pit; the weather was excessively sultry at the time, and the barometer was low. Fire-damp, evolved in great quantity from the Bruno seam, in all probability finally found its way into the engine-house above-bank, as well as into the second level, etc., below. The second explosion (within the pit) may have been started by the accidental dropping down the shaft of some burning substance [*sic auctor*].

On December 13th, 1902, at the Minister-Achenbach pit, near Dortmund, several shots, fired with gelatine-dynamite in a cross-cut, started a fire-damp explosion whereby 5 persons were slightly injured. The dynamic effects were inconsiderable, and coal-dust played no part in the matter. Electric time-igniters were used, and these do not appear to furnish quite the same elements of safety as ordinary electric ignition. New regulations, more stringent than before, have been drawn up for shot-firing in the Minister-Achenbach colliery.

(2) *Mittheilungen über einige der bemerkenswerthesten Explosionen beim Preussischen Steinkohlenbergbau im Jahre 1903.* OFFICIAL. *Zeitschrift für das Berg-, Hütten- und Salinenwesen im Preussischen Staate*, 1904, *vol. lii., B. Abhandlungen, pages* 483-490, *with* 6 *figures in the text.*

In the Hillebrand pit of the Gottessegen colliery, at Antonienhütte in Upper Silesia, an explosion took place during the night-shift of Saturday to Sunday, April 4th to 5th, 1903, with fatal results. Three shots had been fired about midnight in one of the workings where the temperature was exceedingly high (on account, chiefly, of leakage of the cool air brought into the mine through defective brattices), and two shots more were to be fired. Eye-witnesses do not quite agree as to what then happened. At all events, there appears to have been carelessness on the part of the persons concerned. Either a fuse was ignited accidentally by too close contact with a lamp, or a spark falling from a lamp was blown by the current from a compressed-air drill on to gunpowder and dynamite cartridges which had been laid on the floor preparatory to shot-firing. Eight persons suffered severe burns, which proved fatal in some cases. There appears to be little doubt that the coal-dust, produced in abundance by the drilling-machine, played a considerable part in the explosion. The most careful investigation has failed to reveal the slightest trace of fire-damp in the workings. Orders have since been issued to spray the area neighbouring a bore-hole with water before shot-firing; and an accessory ventilator has been set up at the foot of the inclined plane, so as to improve the ventilation of that portion of the workings.

At 2 a.m. on April 26th, 1903, an explosion occurred in the sump of No. 4 level of the Friedlicher Nachbahr colliery, in the mining-district of Hattingen, whereby 5 workmen were more or less severely burnt, 1 dying of his injuries on the following day. The safety-lamps carried by the victims were found properly locked and undamaged; the site of the explosion was never dry, owing to the constant drip of water, and it need hardly be added that coal-dust was conspicuous by its absence; the ventilation of the mine was excellent. The cause of the disaster appears to have been the sudden collapse of part of the sump into a cavity formerly occupied by a mass of coal, but at that moment filled with an accumulation of fire-damp:

this, of course, was immediately ignited by the lamps carried by the pitmen.

Between 5 and 6 p.m. on October 30th, 1903, a fire-damp explosion took place at the 2,132 feet level of the Werne colliery, in the mining-district of Hamm, whereby 3 persons lost their lives. The part of the workings where the disaster occurred had been abandoned for about 1 month, but 2 men and 1 lad had been told off to restart working there that afternoon, and the overman who went with them (to show them what had to be done, and to inspect the place) found it cool, well-ventilated and somewhat damp. The cause of the explosion cannot be determined with certainty, but the available evidence negatives the supposition that the victims had been tampering with their lamps: these were of the single-gauze type, and made by Mr. Seippel of Bochum. There had been a fire in another seam in the same colliery, but this again appears to have had no causal connection with the disaster. L. L. B.

GAS-EXPLOSIONS IN CLAY-PITS, AND THEIR PREVENTION.

Gasexplosionen in Thongruben und deren Verhütung. *By* H. E. Müller. *Jahrbuch für das Berg- und Hüttenwesen im Königreiche Sachsen*, 1904, *pages* A3-A18.

The presence of inflammable mixtures of gases in the underground clay-workings of France and Belgium has given rise, within the last decade or so, to a series of accidents, the attendant circumstances of which were exhaustively dealt with in the *Annales des Mines* for 1895. History is now repeating itself in Saxony, outbursts of inflammable gas being frequently recorded in certain clay-pits. The clay of the neighbourhood of Löthain appears to be especially characterized by the evolution of such gases, and no less than 8 pits in that locality have been scheduled as dangerous by the Saxon Department of Mines. (It is mentioned, by the way, that the use of safety-lamps is made obligatory at depths exceeding 50 feet.) Various accidents which occurred in these pits, with inflammable gas, during the years 1886 to 1903, are briefly touched upon, and it is stated that analysis of a sample of the gas made at Freiberg showed it to contain 64·5 per cent. of methane, 19 per cent. of carbon dioxide, and 15·9 per cent. of nitrogen. The general opinion now is that the gas originates from the decomposition and fermentation of the timbering in the wet clay, in old portions of the workings from which the outer air is excluded. The curious fact that the evolution of methane is in all three countries (France, Belgium and Saxony) more especially characteristic of a certain number of clay-pits, is explicable, on the assumption that the particular bacterium, through the agency of which the decomposition of the timber is effected, is present in those pits only, and not in the others. Compare, in this regard, the exhaustive researches of the late Prof. Renault on the agency of bacteriaceæ in the formation of coal.

In long-drowned metalliferous mines, on the other hand, the decomposition of the timbering appears to have been attended in many cases with the evolution of hydrogen rather than with that of methane; and a more careful study of the question leads the author to the conclusion that the presence of finely-divided organic particles within the substance of the clay itself is quite as important a factor as, if not a more important factor than, the decomposition of the timbering in the evolution of pit-gases. Impregnation of the timbering or its complete removal from old workings are not, there-

fore, the remedies called for by the situation: the only reliable preventives are thorough ventilation and the use of safety-lamps. These are now prescribed by the Department of Mines in the Saxon clay-pits, as also the construction in every case of a second winding-shaft (to permit of the men escaping in the event of an explosion). L. L. B.

EXPLOSION IN A GOLD-MINE IN NEW SOUTH WALES.

Explosion at Lucknow. *By* A. Jaquet. *Australian Mining Standard*, 1903, *vol. xxx., page* 828, *and* 1904, *vol. xxxi., page* 8.

An explosion of fire-damp occurred in the Reform shaft-workings of the D'Arcy Wentworth mines, Lucknow, whereby 2 miners received superficial burns on the face and arms. Inflammable gas, consisting essentially of carburetted hydrogen, produced during the rotting of old mine-timbers under water, was carried by flowing water through a bore-hole into the gallery, where it was mixed with air, and ignited at a naked light.
M. W. B.

FIRE AT THE LAURAHÜTTE COLLIERY, SIEMIANOWITZ, GERMANY.

Der Grubenbrand in der Ficinus-Schachtanlage des Steinkohlenbergwerks Laurahütte bei Siemianowitz am 26. September 1903. *By* — Jaekel. *Zeitschrift für das Berg-, Hütten- und Salinenwesen im Preussischen Staate*, 1904, *vol. lii., pages* 264-269, *and* 1 *plate.*

At the Laurahütte colliery, in Upper Silesia, a fire took place on September 26th, 1903, with the result that the manager and 3 workmen perished by suffocation, and 43 other persons were more or less seriously injured. Pit-fires being very frequent in that coal-field, the system of precautionary and preventive measures has attained a sufficient degree of perfection to be, as a rule, successful in quickly damming off areas of conflagration without injury to life or limb. In most cases, fires arise from spontaneous combustion (to which the Upper Silesian coal is peculiarly liable) in the goaf. Open conflagrations of considerable extent are, fortunately, rare, but when they do occur the inflammability of the coal constitutes an additional source of danger and a vehicle for the spread of the mischief: the disaster here described is attributed to an open conflagration, which escaped notice until too late.

Three seams are worked at the Laurahütte colliery, to which access is gained by 3 independent winding-shafts (the Richter, Ficinus and Knoff shafts): the sole communication between these consisting of certain air-courses and waterways. It was in the district served by the second-named shaft that the fire occurred; this shaft is both the main winding and downcast-shaft, and it has as auxiliaries the Aschenborn shaft for drainage and 4 ventilating-shafts (Ernst, Saara, Holz and Therese). The Caroline seam is 16 to 23 feet thick; it is worked by the pillar-and-stall system customary in Upper Silesia; and fires are extremely rare in the goaf, as this is immediately filled up (after being worked out) with the soft sands and shales which overlie the coal, and is thus made all but air-tight. The number of men at work on the seam in that district of the colliery averaged 250, and the ventilation was so arranged that about 124 cubic feet of fresh air flowed past every man per minute. Shortly after 6 a.m. on the fatal day,

an overman was warned that a fire had broken out in the particular area that was under his charge; and, pending the arrival on the spot of the manager, he took measures to roll back the smoke and gases of combustion by opening up doors in masonry-dams to admit opposing air-currents. He also attempted to limit the area of conflagration by means of a timber-dam. Meanwhile the fire raged so furiously that these measures, and others yet, proved inadequate. Rescue-parties provided with pneumatophores and smoke-masks were beaten back, and even the attempt to leave a still more extensive area to the conflagration and dam it off securely, at about 11 a.m., had to be given up. The Ficinus shaft had to be completely closed off, operations to this end being carried out from the main cross-cut at the 460 feet level and from the Saara shaft. The rescue-parties were finally successful in recovering the bodies of 3 out of the 4 victims who died from suffocation, and in bringing to bank the 43 injured persons who were suffering from burns, contusions, and in some cases carbon-monoxide poisoning.

The cause of the fire has not been ascertained, but one lesson taught by the disaster is that the precautionary measures, which are sufficient to stop such small fires as are frequent in the goaf of Upper Silesian collieries, are inadequate to cope with an extensive conflagration. The coal of the Caroline seam is so tough, that most of the levels driven in it are unprovided with pit-props; nevertheless, there happened to be at the site of the fire a certain amount of woodwork in the shape of wooden tubs, scaffolding, etc., to give plausibility to the supposition that the outbreak was in some unexplained way connected with these. L. L. B.

A NEW SYSTEM OF COMBATTING FIRES IN MINES.

Nouveau Système pour Combattre les Incendies dans les Mines. *By* J. Krzyzanowski *and* St. Wysocki. *Paris*, 1904, 41 *pages, with* 6 *figures in the text and* 3 *plates.*

The authors first consider the causes of fires in mines:—(1) Fires due to inflammation of timber and other easily combustible materials, such as hay and lubricating-oils. They cite several cases in which such fires have caused great loss of life and damage to property. (2) Fires due to inflammation of coal: (*a*) by contact with a flame, and (*b*) by spontaneous combustion. (3) Fires caused by inflammation of coal-dust. And (4) fires caused by explosions of fire-damp.

The authors then contrast the precautions against fires which are taken in large establishments on the surface and in towns, with the general lack of such precautions in mines, notwithstanding that in mines the risk of fire is greater than on the surface, owing to the profusion of inflammable materials and the constant use of artificial lights. The danger from the gaseous products of combustion is also much greater underground than on the surface.

The only means of defence actually available in most mines are: (1) Partial changes in the direction of the air-currents, where doors or ventilating appliances allow of such changes. (2) The modification of the whole system of ventilation, which is a complicated operation requiring much time. (3) The construction of wooden dams after the fire has broken out, in order to arrest the propagation of the products of combustion and to isolate the fire. These measures have been in use for nearly four centuries, and they are inadequate to meet the dangers of fires, owing to the incessant develop-

ment of mines and the increased number of persons employed therein, nor are they in accord with the progress made in mining science.

It is difficult to estimate, even approximately, the speed with which a fire is propagated in timbered mines. The speed varies with the state of the ventilating current and the physical condition of the mine and the timber; the amount and direction of the inclination of the roadways are also factors in the speed of propagation of fires. It is possible, however, to estimate with some precision the route and velocity of the gases of combustion, which is incomparably greater than that of the fire. In a given mine, the velocity of the ventilating current may vary greatly, according to the sectional area of the passages through which it moves. The average speed of the main air-current in different mines may be taken at 400 feet per minute (2 metres per second). It follows that the rate of advance of the smoke and gases from a fire may also be estimated at 400 feet per minute, between the fire and the point of exit of the current. The fire and smoke also advance in the opposite direction where their rate of advance is equal, but the speed in this direction is insignificant, except where the passage is vertical or highly inclined.

It follows from the foregoing observations that in a mine-fire the persons in greatest danger are those between the fire and the point of exit of the air-current. If the length of the main air-current is taken at from 6,000 to 12,000 feet and the speed of the air-current at 400 feet per minute, it follows that the current traverses 3,000 feet of the airway in 7½ minutes, and traverses the whole route in from 15 to 30 minutes. This is about the speed and time in which the gases and fumes traverse the main airway when the fire occurs near the entrance to the mine. A more complete idea of the greatness of the risk in such circumstances is obtained by considering that the mass of noxious gases produced by the burning of the timber in a few feet of roadway, or by the inflammation of a limited amount of fire-damp and coal-dust, or by the combustion of a few hundred pounds of coal, would be sufficient to fill all the mine; and that the fatal effects of these gases on men are produced, not at the end of 1 hour or ½ hour, but, according to the greater or lesser density of the poisonous mixture, at the end of some minutes. Considering the rapidity of the progress of the smoke and gases, it is evident that miners, surprised by the poisonous current, have no chance of escaping. The system of warning by word of mouth is not sufficient to reach the persons interested in all parts of the mine, or the warning only reaches them when the intake airway near their working-places is saturated with poisonous gases.

The system proposed by the authors for dealing with fires in mines consists in the pre-establishment of dams capable of being instantly closed in case of fire, and situated in such positions as to divide the mine into sections, which could be isolated by the closure of the dams. The dams would be fitted with doors of such size, that when open, as in ordinary times, they would not impede the ventilation. To illustrate the system a diagram is given showing the airways of a mine producing 500,000 tons per annum, with the positions of the preparatory dams, 32 in number. These dams are placed as far as possible near points where currents of air divide or come together, so that access to one side of the dams may be easily maintained by ventilation. Where this is not practicable, special means for ventilation should be provided. The dams may be made of wood or bricks, the openings being kept as large as practicable, so as not to impede the ventilation. The doors may

be of wood or sheet-iron, made as air-tight as possible, and there should always be a supply of mortar or moist clay to make them quite air-tight. Places which should be specially guarded, as being by their nature extra dangerous in case of fire, are vertical shafts or staples, timbered engine-houses, stables, hay-depôts and timbered roads containing steam-pipes.

The organization of the service for closing the doors in case of fire is stated to have been elaborated in another work entitled *Incendies Miniers*. Certain officials are entrusted with the work, and special signals arranged. A method for operating the doors by means of electricity from a central station and a system of electric signals are described. The estimated cost of a dam is £5, and of the electrical apparatus £7 per dam. W. N. A.

CENTRIFUGAL PUMPS.

Pompe Centrifuge à Haute Pression: Système de Laval. *By* K. Sosnowski. *Mémoires et Compte-rendus des Travaux de la Société des Ingénieurs Civils de France*, 1904, *vol. lvii., pages* 233-241, *with* 8 *figures in the text.*

The volume delivered by centrifugal pumps can be considerably varied without greatly impairing the efficiency; and the consumption of a steam-turbine, coupled with a centrifugal pump, may be reduced to 20 pounds (8·5 to 9 kilogrammes) of steam per horsepower per hour in water raised. Tests made during the last few years have shown that centrifugal pumps are capable of affording high pressures with a good mechanical yield.

Trials of the Laval high-pressure pumps date from the beginning of 1899, although the actual applications are more recent. Lifts of 328 feet (100 metres) and upwards are obtained by means of high speed; and it may be considered generally that the height of lift is in direct ratio with the speed. As regards the motive power, steam-turbines afford the highest speeds, so that it was quite usual, for high lifts, to couple the pump directly to the turbine; but, on account of the high number of revolutions, the revolving portion of the pump becomes very much reduced in diameter, and this necessarily restricts the sectional area of the suction-pipe, only permitting of the delivery of small volumes. Accordingly, in order to raise large volumes of water, the main pump received the addition of an auxiliary one, mounted on the intermediate shaft of the turbine, and revolving at a lower speed. This auxiliary pump may have suitable dimensions for raising by suction the quantity of water required, and delivering it under slight pressure to the high-speed pump. A Laval steam-turbine of 50 horsepower, making 20,000 revolutions per minute, is mounted on the same shaft as a high-pressure centrifugal pump, capable at this speed of raising 220 gallons (1,000 litres) per minute to a height of 492 feet (150 metres) in a single lift. The auxiliary pump, of low pressure, is only intended to supply the high-pressure pump with the quantity of water which it could not, on account of the small size of the orifices, raise by its own suction.

The first application in France of these high-speed, high-pressure pumps to raising mine-water was made at the Lens colliery. This turbine-pump, capable of raising 22,000 gallons (100 cubic metres) per hour to the height of 853 feet (260 metres), subsequently increased to 1,148 feet (350 metres), is constituted by a turbine of 150 horsepower directly driving a high-pressure centrifugal pump, and also, by means of a speed-reducer, a low-pressure centrifugal pump, the former making 13,000 revolutions and the second 650

revolutions per minute. The low-pressure pump raises the mine-water about 10 feet (3 metres) and forces it, with a pressure of about 33 feet (10 metres) to the high-pressure pump, which raises it to the surface in a single lift; there is a retaining-valve on the delivery-pipe and also, in case it should fail, a safety-valve on the low-pressure pump. As this plant is underground, the moisture from the steam and the hot water of condensation have to be dealt with: but steam-traps and good cleading of the pipes ensure sufficient dryness of the steam, and the water of condensation is removed without mixing with the mine-water. The condenser has its own feed-pump (mounted on the same shaft as the low-pressure pump) which supplies it with mine-water at nearly constant temperature, so that the vacuum is very uniform. If the efficiency of centrifugal pumps alone is a little lower than that of plunger-pumps, such is not the case when the centrifugal pump is driven directly by a steam-turbine, while they are smaller and less costly, and work without shock.

J. W. P.

METHOD OF PREPARING PEAT FOR BRIQUETTES.

Ein neues Verfahren zur Aufbereitung von Torf für Briquettirungs- und andere Zwecke. *By* GUSTAV KROUPA. *Œsterreichische Zeitschrift für Berg- und Hüttenwesen*, 1902, *vol l.*, *pages* 57-60 *and* 79-81, *and* 4 *figures.*

The fresh peat, containing 80 to 85 per cent. of moisture, is passed through a Schlickeysen or Dollberg press, converted into a homogeneous mass, and delivered through a copper-mouthpiece as an endless band, about 24 inches wide and 2 inches thick. It is then carried on a belt-conveyor, and is cut into lengths of about 24 inches; these are delivered into a series of revolving chambers, which discharge the lengths of peat into an appliance where it is enclosed in strong sacking, without having been touched by hand at any stage of the process. From this appliance, the filled bags fall through a hopper into a double rotary chamber, where the mouth of the bag is automatically closed, and the bag is then delivered into a truck holding about 30, each in a separate compartment. When the truck reaches the hydraulic press, which serves to expel the moisture from the peat, a slotted plate in the truck-bottom is caused to slide by means of a lever, so that the bags fall through into the press-plates, which are connected with one another and with the press-head by means of chains, so that when the press-head is lifted the plates are returned to their original position. From the press, the peat (which now contains only 50 to 60 per cent. of moisture) is discharged on to a vibrating conveyor, which carries it to a floor where the bags are emptied by youths. It is then fed to a breaker, and transferred to a drying-oven, where the water is further reduced to 12 or 15 per cent.; finally the dried product is conveyed to the briquette-press. The apparatus will deal with 1,145 cubic feet of crude peat *per diem* of 20 hours. C.S.

MEASURING THE VOLUMES DELIVERED OF GASEOUS SUBSTANCES.

Mesurage des Débits des Corps gazeux. *By* N. FRANÇOIS. *Annuaire de l'Association des Ingénieurs sortis de l'École de Liége*, 1904, *vol. xvii.*, *pages* 243-271, *with* 13 *figures in the text.*

Now that every effort is being made to turn blast-furnace gases to the best possible account, the importance of measuring the gas-volumes delivered

has specially asserted itself. Of the various methods for this purpose, namely, direct measuring, the calorimetric method, the chemical method and indirect measurement by determining the speed of flow, the most correct and trustworthy is direct measurement by the gasometer; but, unfortunately, this requires so cumbersome and costly a plant, that it can only be applied in exceptional cases.

The indirect measurement, which consists in determining the speed of the current, in accordance with the *vis viva* of the gas, was first suggested by Mr. Pitot, towards the middle of the eighteenth century, for gauging rivers; and the method was subsequently improved by Mr. Darcy. It has been in turn tried, abandoned and lastly re-employed with success by the author, whose greatest difficulty was to render it applicable to comparatively slight speeds of off-flow. Its principle is the following:—If to a pipe, in which a gas passes, a pressure-gauge be applied, with the end dipping into the pipe and terminating in a plane perfectly parallel with the axis of the pipe, the gauge will indicate a pressure which is not influenced by the flow of the gas; but if the end of the tube be modified so that the plane be set at right angles to the axis of the pipe and facing the current, the pressure will increase, and the increase of pressure will correspond with the dynamic pressure to which the plane is subjected owing to the resistance that it opposes to the current, this resistance corresponding with the *vis viva* of the gas. If the second branch of the gauge, instead of being left free, be also put in connection with a tube dipping into the pipe, the mouth of which tube is perfectly parallel with the direction of the current, we shall obtain the Darcy tube.

In order to ascertain the volume delivered, it is sufficient to multiply the sectional area of the pipe by the speed of flow; but, to obtain absolutely correct results, such speed must be very uniform over the whole sectional area of the pipe. This, however, is never the case, if only on account of friction due to the sides; but, for large metal-pipes, this influence is slight. As the difference of level will generally be insignificant, recourse must be had to a special gauge, and that best known for slight pressures is the manometer with an inclined tube.

The first attempts made by the author with the Darcy tube and a manometer with an inclined tube were not encouraging; and he has introduced various modifications into the method with the object of (1) rendering possible the determination of low velocities; (2) only requiring portable instruments of easy management; and (3) avoiding certain causes of error, especially those due to variations in the speed of flow.

The method, thus improved, has been applied with equal success to gauging blast-furnace gas at the furnace-mouth, at the hot-air stoves, at the boilers, or at the gas-motors; and this success naturally induced an extension of its application to other purposes, especially the passage of air through mine-workings. In that case, what is chiefly to be sought is a method, only requiring apparatus easily moved about and manipulated, while giving approximately correct results for speeds varying from 7 to 40 feet per second; and, lastly, it is important that the readings be taken as instantaneously as possible, without being too much influenced by the presence of the observer in the air-way. The method is specially applicable to testing fans; and it has also been applied to measure the air delivered by blowing-engines and air-compressors, for which latter purpose the following process was adopted. In the absence of a compressor, the air of which

could be gauged in a gasometer, the apparatus was compensated by means of receivers. On the delivery-column of an air-compressor, between two receivers, was mounted the Pitot tube; and this communication-pipe of the receivers was provided with a set of valves permitting either the escape of the compressed air and the evacuation of the second receiver, or of sending this air into the second receiver. Before beginning an observation, the latter was, therefore, emptied; and then, when the time was taken, the valve open to the air was closed, and the air sent into the gauging-receiver. Thanks to a pressure-gauge mounted on the pipe, the opening of the valve between the pipe and the receiver was so regulated that the pressure in the pipe remained almost constant. As the air-compressor worked with a constant pressure, its running was also constant; and in this manner, while the pressure varied from *nil* to x atmospheres in the receiver, the air in the pipe, maintained at a constant pressure, also circulated with an almost constant speed. The capacity of the gauging-receiver, as also the initial and final pressures and temperatures being known, it was easy to determine the quantity of air forced into the receiver during the observation, and to deduce from it the mean speed of flow in the pipe. The concordance between the results obtained by gauging with the receiver and those afforded by the Pitot method gives confidence in this method, as regards its application to compressed air. J. W. P.

PATIO PROCESS OF SILVER-AMALGAMATION.

The Patio Process of Amalgamation of Silver-ores. *By* Manuel Valerio Ortega. *Transactions of the American Institute of Mining Engineers*, 1901, *vol. xxxii., pages* 276-285.

The ore from the mine, after being hand-picked, is reduced in *arrastras* or *tahones* to fine slime. After the slime has acquired a suitable consistency by the evaporation, through the sun's heat, of a part of the water which it contained, it is spread upon the *patio* or amalgamating-floor, where it is mixed with 5 or 6 per cent. of common salt. The next day, a certain amount of cupric sulphate is added, and immediately afterwards mercury, in the proportion of 8 units to each unit of silver contained in the mineral. These chemicals are thoroughly mixed with the slime by means of horses or mules trampling over it, and this is continued from 2 to 5 weeks. Amalgamation being finished, the slime is transferred to deep, circular stone vats, through which water is passing agitated by a revolving paddle. The amalgam and other heavy metalliferous materials collect at the bottom, while the light earthy impurities are held in suspension and carried away. The author discusses in detail the chemical theory on which the process is based.

R. W. D.

THE SALTPETRE-INDUSTRY OF CHILE.

Die Salpeterindustrie Chiles. *By* Dr. — Semper *and* Dr. — Michels. *Zeitschrift für das Berg-, Hütten- und Salinenwesen im Preussischen Staate*, 1904, *vol. lii., B. Abhandlungen, pages* 359-482, *with* 13 *figures in the text and* 12 *plates.*

The first portion of this memoir deals with the conditions of occurrence, form, and origin of the nitrate-deposits; the second, with the mode of winning and treating the nitrates, and with the cost of plant, labour, transport, etc.;

while the third portion deals with the history and the economic and legal aspects of the industry.

The Chilian nitrate-fields are practically confined to the two northernmost and rainless provinces of Tarapacá and Antofagasta. The region is orographically divisible into four distinct belts, parallel with the Pacific seaboard, these being, from west to east: (1) The coastal Cordilleras, which abut steeply on the ocean, but fall eastward in gentler slopes—on which latter the nitrate-deposits have been mainly formed and preserved; (2) the high tableland of the Pampa de Tamarugal; (3) the foothills of the Andes; and (4) the great Cordilleras of the Andes themselves. Dust-storms are of almost daily occurrence in the Pampas; and earth-tremors are observed in the Atacama district two or three times a week, on the average. The authors believe, indeed, that the network of fissures which have split up the saltpetre-conglomerates into a chaos of blocks (*tablas*) is the outcome of seismic phenomena. Many of the features of the country are characteristic of æolian agencies—dunes have accumulated in favourable localities, exposed faces of rock show unmistakable marks of wind-erosion, and so forth. The rainfall, when it does occur, assumes somewhat the character of a waterspout, washes great cavities in the soil, and piles up huge masses of detritus on the floor of the Pampas.

After pointing out the unsatisfactory want of precision about the term *caliche*, both from the lithological and the stratigraphical point of view, the authors proceed to show that the nitrate-deposits may be subdivided into four essentially-distinct categories, as follows: (*a*) Beds, nests and lenticles of the impure sodium nitrate, associated with chloridic and sulphatic salts and stony and earthy substances, overlying loose Quaternary rubble and gravel, and underlying a series of saline conglomerates, gravels, etc., of variable thickness; (*b*) impregnations of the weathered crust of Mesozoic eruptive rocks by sodium nitrate and the associated salts; (*c*) infillings of cavities in the Jurassic limestone; and (*d*) efflorescences at the surface of the saline steppes (*salares*). The first group is perhaps the only one of real importance, from the industrial point of view. A detailed description of the deposits is followed by a discussion of the various theories mooted as to their origin. Without committing themselves to a definite conclusion in this regard, the authors appear to think that, among the genetic agencies to be reckoned with, is electric tension occurring in a damp atmosphere, combined with the action of wind-borne guano-dust on the saline deposits of shrunken lagoons.

The method of winning the saltpetre has undergone but little alteration since the start of the industry. The workings are all but universally open-cast, and take the form of long, straight trenches, the direction of which is conditioned by the levels and greatest extension of the assigned area. As a rule, a trench is begun by shot-firing with blasting-powder in some of the bore-holes put down to test the value of the deposit. The gunpowder is usually manufactured on the spot; the stemming consists of earth and stone, very closely packed; and the fuse is of the ordinary type, with a gunpowder-core. Wages, and the very currency in which they are paid, are subject to continual variation: they vary, too, from district to district of the nitrate-fields. The range of the prime cost of winning a metric centner or quintal (50 kilogrammes or 110 pounds) of crude saltpetre has been variously estimated as lying between a minimum of 4·3d. and a maximum of 14·6d., or between a minimum of 7·7d. and a maximum of 11·7d.

The nitrate is extracted from the crude stuff or *caliche* by leaching at a high temperature; the insoluble residues are separated off from the mother-liquor, and the pure nitrate is crystallized out from this. The cost of treatment depends on so many factors, that it varies within wide limits. Among the bye-products obtained are iodine, perchlorate of potash, common salt and sulphate of soda. The question of water-supply, not only for the nitrate-factories, but for domestic use as well, is one that bristles with difficulties in these rainless regions. For instance, the water obtained from subterranean streams in the Pampa de Tamarugal is so full of compounds of lime, magnesia and alumina that it cannot be utilized in the nitrate-works until it has undergone treatment with quicklime and soda; then, in the case of very many springs, the water is so excessively saline that it is useless for domestic purposes. In the Toco district a good supply of slightly brackish water is yielded by the Loa river. The fuel, without which the works could not exist, is almost entirely British and Australian coal; in some cases, a small proportion of the inferior coal got in Southern Chile is mixed with the imported coal. The native sulphur, used in the process of extracting the iodine, was at one time imported from Sicily, but is now got from deposits in the Andes.

In 1902, the number of workpeople employed in the nitrate-fields amounted to 24,538 (nearly 6 times as many as in 1887)—of whom 71 per cent. were Chilians, mainly immigrants from the southern provinces. The output per head diminished continuously from 1900 to 1902. Wages have risen of late years, as the demand for suitable labour is greater than the supply. The owners of the works generally make a good profit out of the stores connected with them, as, in view of the absence of ordinary shops and the remoteness of the nitrate-fields from the chief centres of population, the workpeople are necessarily driven to make most of their purchases from such stores. Some of the statements advanced by the authors in this connection verge on the libellous.

Nearly half of the ordinary revenue of Chile (49 per cent.) is derived from the export-duties on nitrate and iodine; while the sales by auction of nitrate-fields belonging to the Government form a big item in the non-recurring revenue. In short, the finances of that State may be said to depend all but entirely on the saltpetre-industry nowadays, an industry carried on in territory that belonged mainly to Peru and Bolivia, until its annexation by Chile as the result of the war of 1879-1883. At the present rate of consumption, it would take about half a century to exhaust the nitrate-fields; but the demand shows signs of more rapid expansion than had been foreseen, and it is quite within the bounds of possibility that the fields will be exhausted long ere another 40 years have elapsed.

The memoir, of which a brief sketch has been given, is a store-house of facts bearing on every aspect of the Chilian nitrate-industry, and is likely to rank as a classic (at any rate among German readers) for a long time to come. L. L. B.

BOILER-ACCIDENTS IN FRANCE DURING 1902.

Bulletin des Accidents d'Appareils à Vapeur survenus pendant l'Année 1902. ANON. *Annales des Mines*, 1903, *series* 10, *vol. iv.*, *pages* 564-576, *and* 3 *plates.*

The number of boiler-accidents recorded in France during 1902 amounted to 34, no less than 23 lives being lost thereby and 32 persons greviously injured. With regard to the causes, 6 accidents were traced to defective

installation, 17 to defective upkeep, 11 to improper usage, and the actual cause of 5 remained undetermined. Smoke-tube boilers were involved in 16 cases, water-tube boilers in 3, non-tubular boilers in 10, and ordinary "recipients" in 5.

The only accident recorded at a mine took place on June 26th, at the iron-mine of Diélette, in Lower Normandy. Here, a horizontal cylindrical non-tubular boiler was suddenly rent over a length of 5 feet, and the fireman was killed on the spot. The dynamic effects were otherwise not as considerable as might have been expected, and the bursting of the boiler was undoubtedly due to insufficiency of water. The water-gauges appear to have been badly planned.

On November 3rd, at a slate-quarry of Pierrie in Britanny, a horizontal semi-tubular boiler, fed with decidedly acid water, suddenly burst, killing a fireman and badly injuring the engineman. The accident was evidently due to long-standing internal corrosion of the boiler-plates.

Most of the other accidents occurred in various factories (chemical and metallurgical, weaving and spinning industries, threshing-mills, etc.).

L. L. B.

ELECTRIC MINE-PLANT AND LOCOMOTIVES AT LA MURE COLLIERY, FRANCE.

Les Installations Électriques de la Compagnie des Mines d'Anthracite de La Mure, Isère. *By* LÉON DE CHARENTENAY. *Bulletin de la Société de l'Industrie Minérale*, 1904, *series* 4, *vol. iii., pages* 79-117, *with* 13 *illustrations in the text and* 2 *plates.*

In 1895, a scheme of electric power-transmission was prepared for (1) substituting electric motors for insufficient steam-boilers and engines at various points, (2) haulage, ventilation, rock-drilling, and all purposes for which electricty affords a simple power-agent, (3) driving the new workshops, and (4) lighting. As the slack and impure fuel is disposed of to advantage, and the region abounds in water-courses, the company had every reason to employ "white coal" instead of black for producing its electric current, and has acquired water-rights that can yield 50,000 horsepower. Two electricity companies, the first with a generating-station for 10,000 horsepower, have been installed; and a third company will supply additional power, as a reserve for the principal motors.

As the electricity supply-companies had adopted triphase current of 50 periods per second, at pressures of 10,000 and 15,000 volts, it was natural that the mining company should arrange for a distribution of triphase current of 50 periods, but with uniform and suitable secondary tensions. For the surface-works a 500 volts compound tension was chosen, as best satisfying the conditions of efficiency and insulation, always critical for conductors and motors in such dusty places as a screening-plant; and for the motors in the underground workings, quite free from gas, triphase current was also adopted, with a compound tension of 185 volts, as best fulfilling the safety-conditions imposed by various mine-regulations.

The 500 volts current supplied by the electric companies is received by two white marble switch-boards, provided with the appliances for measurement, distribution and safety, and connected by a common line which, in the event of break-down at either of the generating-stations, ensures the working of all the motors. There are at present twenty triphase asynchronous

motors of 3, 10, 15, 20, 25, 30, 50, 120 and 230 horsepower, and all are well earthed, so that, if contact should be made between the winding and the frame, the latter, of the same potential as the earth, can be touched with impunity. The 230 horsepower motor gives out this power, at a speed of 420 revolutions per minute, with an efficiency of 92 per cent.

The air-lines are constituted by three naked tinned-copper wires or cables, hung by porcelain-insulators on brackets, or on posts about 35 feet (10 to 12 meters) high; but, inside buildings, the wires or cables are insulated and carried by porcelain sheaves, well out of reach. The current is led underground by cables, constituted by three cords or strands of copper-wire, insulated from one another and further very carefully insulated, and also armoured by steel ribands for the horizontal, and by steel wires, capable of sustaining a length of 328 feet (100 metres), for the vertical portions.

The 500 volts pressure permits of taking the current to the farthest extent of the workings without too great loss; and, as a tension of 185 volts has been adopted for the locomotives and hauling-engines, underground transformers became necessary. The latter, with closed magnetic circuits, are provided with cast-iron casings of barrel-form, for protection against dust and damp, while they can be filled with oil for completely immersing the transformers if the necessity should arise. The metallic masses, carefully earthed, so that they may be touched without danger, are enclosed in masonry-lined chambers, access to which can only be gained by those in charge. Each transformer has its switchboard, and each of the three motors has a separate conductor for leading up the 185 volts current. The conductors, similar to those in buildings on the surface, are carried by porcelain-sheaves along the sides of the workings.

The Ganz hauling-engines, each capable of lifting 1 ton vertically at a speed of $3\frac{1}{4}$ feet (1 metre) per second, are placed at the top of inclines, about 820 feet (250 metres) distant from the transformers. The spur-wheels on the motor-shaft are of compressed green hide; and the gear is cased in. The motors, which make 965 revolutions per minute, can exert 23 horsepower with a current of 185 volts, showing an efficiency of 84 per cent. with full load, or of 50 per cent. including losses by transformation.

The erection of a large screening-plant in 1898 brought about such an increase of output, that the old haulage-roads became insufficient; and mechanical haulage imposed itself, with the following conditions:—Saving of labour by concentrating all the haulage on a single road; rapidity and regularity in conveying the coal from the working-faces to the screening-plant; better utilization of the rubbish from preparatory workings; and safety for the workmen.

As the roads could only receive a single line of way, the electric locomotive alone appeared to afford a practical solution of the problem; and a single engine should suffice to take off 1,200 tubs of coal in 10 hours over a distance of 0·62 mile (1 kilometre) at a speed of 10 miles (15 kilometres) per hour. It is supplied with triphase current at 185 volts, and is provided with three current off-takes, all return by the rails being avoided, not only on the score of safety, but also because iron opposes great resistance to an alternating current, owing to induction. With 40 tubs in a set, the locomotive can make 30 double journeys in the day of 10 hours, giving 10 minutes for each run and leaving 6 minutes for shunting and contingencies.

The road, of 31 inches (785 millimetres) gauge, is laid with 28 pounds (14 kilogrammes) flange-rails to a maximum gradient of 1 in 64 (15·5 per thousand)

and with a minimum curve-radius of 33 feet (10 metres). The tub, weighing 5 cwts. (250 kilogrammes) holds 10 cwts. (500 kilogrammes) of coal or 14 cwts. (700 kilogrammes) of rubbish; and the gradient is in favour of the coal, which gives the coal-train a weight of 35 tons including engine, against 22 tons for the rubbish, the quantity of which is about one fourth of the volume of coal extracted. The maximum resistance to be overcome occurs, therefore, when the 22 tons train mounts a gradient of 1 in 64.

The locomotive (with another in reserve) is calculated for a pull of 4,918 footpounds (671 kilogrammetres) corresponding, at a speed of 10 miles (15 kilometres) per hour and with a loss of 10 per cent. in the gear, to 41 effective horsepower; and a Ganz vertical-shaft 25 horsepower electromotor, liberally designed, so as to be capable of giving out 47 horsepower and of starting a train under the most unfavourable circumstances, was adopted.

The three-wire distribution required an arrangement permitting the engine to pass easily, without stopping at the points (switches) in the track, and to run in both directions without turning and without the trolley being shifted. The hardened copper-wires, 0·39 inch (10 millimetres) in diameter, are placed one at the centre-line of the roof, and the other two laterally, in the same vertical plane, and at a perfectly regulated distance from the centre-line of the road.

The engine, which has been running regularly since January 12th, 1903, has given every satisfaction. J. W. P.

MINING LAWS OF MEXICO.

A Synopsis of the Mining Laws of Mexico. By Richard E. Chism. *Transactions of the American Institute of Mining Engineers*, 1901, *vol. xxxii., pages* 4-55.

Prior to 1884, mining in Mexico was governed mainly by the "Ordinances of Mining" enacted by the King of Spain in 1783. In 1884, these ordinances were repealed, and the laws of all the states were made uniform. The mining code of 1884 was based on a working tenure of mining property, under conditions hard to fulfil and fruitful of litigation. A new law was introduced in 1892, giving the miner the property of his mines in an irrevocable, perpetual and secure form, through the payment of a yearly tax, with full liberty as to methods of work and the amount of work to be done. The author gives a synopsis of the 1892 regulations, arranged in an orderly manner under 17 different heads. R. W. D.

II.—BAROMETER, THERMOMETER, ETC., READINGS FOR THE YEAR 1903.

By M. WALTON BROWN.

The barometer, thermometer, etc., readings have been supplied by permission of the authorities of Glasgow and Kew Observatories, and give some idea of the variations of atmospheric temperature and pressure in the intervening districts in which mining operations are chiefly carried on in this country.

The barometer at Kew is 34 feet, and at Glasgow is 180 feet, above sea-level. The barometer readings at Glasgow have been reduced to 32 feet above sea-level, by the addition of 0·150 inch to each reading, and the barometrical readings at both observatories are reduced to 32° Fahr.

The statistics of fatal explosions in collieries are obtained from the annual reports of H.M. Inspectors of Mines, and are also printed upon the diagrams (Plates XXVIII. and XXIX.) recording the meteorological observations.

The times recorded are Greenwich mean time, in which midnight equals 0 or 24 hours.

TABLE I.—SUMMARY OF EXPLOSIONS OF FIRE-DAMP OR COAL-DUST IN THE SEVERAL MINES-INSPECTION DISTRICTS DURING 1903.

Mines-inspection Districts.	Fatal Accidents.			Non-fatal Accidents.	
	No.	Deaths.	Injured.	No.	Injured.
Cardiff	2	2	4	2	2
Durham	0	0	0	8	9
Ireland	0	0	0	0	0
Liverpool	0	0	0	3	5
Manchester	0	0	0	0	0
Midland	0	0	0	4	4
Newcastle-upon-Tyne ...	1	1	0	7	16
Scotland, East	4	5	4	22	29
Do. West	2	3	1	47	65
Southern	0	0	0	2	2
Staffordshire	1	1	1	8	9
Swansea	1	2	0	22	29
Yorkshire	0	0	0	9	13
Totals	11	14	10	134	183

TABLE II.—LIST OF FATAL EXPLOSIONS OF FIRE-DAMP OR COAL-DUST IN COLLIERIES IN THE SEVERAL MINES-INSPECTION DISTRICTS DURING 1903.

1903.	Colliery.	Mines-inspection Districts.	Deaths	No. of Persons Injured.
Feb. 9, 1·30	Stanrigg	Scotland, East ...	1	1
,, 24, 22·30	Aldridge (No. 1)... ...	Staffordshire ...	1	1
,, 25, 22·30	Darran	Swansea	2	0
Mar. 23, 19·30	Ferndale (No. 5 Pit) ...	Cardiff	1	3
June 10, 12·30	Biggarford	Scotland, East ...	1	3
July 17, 6·45	Bogleshole (No. 4 Pit) ...	Scotland, West ...	2	1
,, 24, 11·15	Garriongill	Scotland, East ...	1	0
Oct. 5, 0·30 to 3·30	Westburn (No. 2 Pit) ...	Scotland, West ...	1	0
Nov. 9, 21·40	Llwynypia (No. 3 Pit)...	Cardiff	1	1
,, 12, 2·0	Stargate Pit	Newcastle-upon-Tyne	1	0
Dec. 11, 22·30	Braidhurst	Scotland, East ...	2	0
			14	10

TABLE III.—LIST OF NON-FATAL EXPLOSIONS OF FIRE-DAMP OR COAL-DUST IN COLLIERIES IN THE SEVERAL MINES-INSPECTION DISTRICTS DURING 1903.

1903.	Colliery.	Mines-inspection Districts.	No. of Persons Injured.
Jan. 7, 4·45...	West Tees (Railey Fell) ...	Durham	1
,, 7, 8·30...	Dewshill	Scotland, East ...	1
,, 8, 17·30...	Wednesbury Oak (No. 22 Pit)	Staffordshire	1
,, 9, 7·30...	Glangarnant	Swansea	1
,, 9, 15·0 ...	Noyadd	Do.	1
,, 13, 19·30...	Hook	Do.	1
,, 19, 3·0 ...	Walkmill	Newcastle-upon-Tyne	3
,, 21, 16·30...	Auchenharvie (No. 5 Pit)	Scotland, West ..	1
,, 21, 20·0 ...	Mountain	Liverpool	2
,, 22, 6·30...	Newbattle	Scotland, East ...	1
,, 23, 3·15...	Duffryn Rhondda	Swansea	1
,, 30, 19·30...	Dalziel and Broomside ...	Scotland, East ...	1
Feb. 1, 10·30...	Newbattle	Do. ...	1
,, 3, 8·40...	Clyde (Townlands No. 1 Pit)	Scotland, West ...	1
,, 6, 15·0 ...	Millburn	Do. ..	2
,, 9, 6·30...	Pumpherston (oil-shale) ...	Scotland, East ...	4
,, 10, 10·0 ...	Manners	Midland	0
,, 15, 23·0 ...	Pennant Hill	Staffordshire	2
,, 19, 2·0 ...	Onllwyn	Swansea	1
,, 23, 8·0 ...	Limefield	Scotland, East ...	1
,, 23, 10·0 ...	Auchincruive (Mossblown No. 2 Pit)	Scotland, West ...	1
,, 26, 7·0 ...	Struther (No. 5 Pit) ..	Do. ...	1
,, 26, 15·45...	Dillwyn	Swansea	1
,, 27, 5·30...	Inkermann (Walkinshaw No. 2 Pit)	Scotland, West ...	1
Mar. 6, 8·0 ...	Oakley	Scotland, East ...	1
,, 12, 10·0 ...	Lanemark (No. 2 Pit) ...	Scotland, West ...	3
,, 12, 19·30...	Holytown (No. 12 Pit) ...	Do.	1
,, 13, 3·0 ...	Mwrwg Vale	Swansea	1
,, 16, 7·30...	Glengarnock (No. 6 Pit) ...	Scotland, West ...	2
,, 16, 8·30...	Blackwell (A Pit)... ...	Midland	1
,, 17, 15·15...	Bogleshole (No. 4 Pit) ...	Scotland, West ...	1
,, 19, 9·0 ...	Pumpherston (oil-shale) ...	Scotland, East ...	1

TABLE III.—*Continued.*

1903.		Colliery.	Mines-inspection Districts	No. of Persons Injured.
March	27, 9·0	Whitehill (No. 1 Pit) ...	Scotland, West ..	1
,,	31, 15·30..	New Cwmgorse ...	Swansea	1
April	7, 10·0 ...	Garriongill	Scotland, East .	3
,,	9, 12·0 ..	Crigglestone	Yorkshire	1
,,	11, 11·0 ..	New Cwmgorse	Swansea	2
,,	27, 8·0 ..	Cynon ...	Do. ...	1
May	2, 13·0 ...	Over Dalserf	Scotland, West ...	2
,,	11, 17·0	Caerbryn	Swansea	1
,,	12, 1·0	Gartness	Scotland, East	1
,,	16, 9·30..	Dunaskin (No. 2 Pit) ..	Scotland, West .	1
,,	21, 10·10...	Ravensworth	Newcastle-upon-Tyne	1
,,	28, 14·15...	Throckley	Do. ...	1
,,	29, 19·0 ...	Blantyre Ferme ...	Scotland, West ..	1
,,	30, 12·0 ...	New Cwm Mawr ...	Swansea ..	1
June	4, 8·30..	Auchincruive (Mossblown No. 1 Pit) ...	Scotland, West ...	1
,,	8, 6·50...	Tareni	Swansea	3
,,	8, 22·0 ...	St. John's	Midland ...	1
,,	13, 7·30...	Park Oval	Liverpool	1
,,	14, 20·0 ..	Dunnikier	Scotland, East ..	1
,,	20, 12·0 ..	Victoria	Swansea ...	2
,,	22, 11·0 ...	Butterknowle	Durham	1
,,	23, 9·0 ...	Bourtreehill (Capringstone No. 7 Pit)	Scotland, West ..	1
,,	25, 6·30...	Philpstoun (oil-shale) ..	Scotland, East .	1
,,	26, 22·20 .	Dumbreck (No. 2 Pit)	Scotland, West .	1
July	2, 10·0 ..	Wednesbury Oak (No. 22 Pit)	Staffordshire	1
,,	2, 17·15...	Gilwen	Swansea	1
,,	8, 21·30..	Haugh (No. 1 Pit)... ...	Scotland, West .	1
,,	10, 10·0 ...	Westburn (No. 2 Pit) ...	Do. ...	1
,,	10, 14·30..	Auchenharvie (No. 1 Pit)	Do. ...	1
,,	16, 17·30...	Wester Queenslie (No. 2 Pit)	Do. .	1
,,	17, 7·30...	Gordon Navigation .	Swansea	1
,,	17, 23·0 ..	Wallyford	Scotland, East ...	1
,,	22, 15·30...	Blaencaegurwen	Swansea	1
,,	23, 9·30.	Rheola . ..	Do. ..	1
,,	24, 15·45	Old Roundwood	Yorkshire	2
Aug.	14, 19·15...	Black Brook	Liverpool . ..	2
,,	15, 7·0 ..	Bonvilles Court	Swansea ...	2
,,	18, 2·0 ..	Silverwood	Yorkshire	1
,,	18, 10·30...	Calderbank (No. 2 Pit) ...	Scotland, West ..	1
,,	20, 15·0 ..	Lingdale	Durham ...	1
,,	21, 2·0 ..	Stonelaw (No. 1 Pit)	Scotland, West ..	2
,,	27, 5·0 ..	Benwell	Newcastle-upon-Tyne	3
,,	28, 9·0 ..	Llwyn	Swansea	1
,,	28, 14·0 ...	Woodhall	Scotland, West ..	1
Sept.	1, 9·15...	Crigglestone	Yorkshire	2
,,	2, 18·0 ...	Charles	Do.	1
,,	2, 22·30...	Throckley	Newcastle-upon-Tyne	1
,,	7, 6·0 ...	Crigglestone	Yorkshire	1
,,	7, 8·0 .	Souterhouse ...	Scotland, West ..	1
,,	9, 16·0 ..	Drumpeller (No. 4 Pit) ...	Do. ..	1
,,	10, 9·30 .	Wester Queenslie (No. 2 Pit)	Do. ..	1
,,	10, 13·0 ...	Wednesbury Oak (No. 6 Pit)	Staffordshire . ..	1
,,	10, 17·40 .	Madeley Court (No. 3 Pit)	Do. .	1
,,	10, 19·30...	Schoolfield (No. 2 Pit) ...	Do. ...	1
,,	13, 2·30...	Lodge Mill	Yorkshire	1

TABLE III.—*Continued.*

1903.		Colliery.	Mines-inspection Districts.	No. of Persons Injured
Sept.	25, 13·0 ...	Meiros	Cardiff	1
,,	25, 18·0 ...	North Skelton	Durham	1
,,	25, 19·30...	Bartonholm... ..	Scotland, West ..	4
,,	28, 14·30..	Roschall (No. 5 Pit) ...	Do. ...	1
Oct.	1, 5·30..	Bridgeness	Scotland, East ...	1
..	6, 10·15...	Fishley (No. 4 Pit) ..	Staffordshire	1
..	8, 14·10...	Nitshill (No. 2 Pit) ..	Scotland, West	2
..	12, 13·15...	Preston	Newcastle-upon-Tyne	5
,,	12, 13·45...	Kirkwood (No. 1 Pit)	Scotland, West .	2
..	12, 15·0 ...	Dumbreck (No. 2 Pit) ...	Do. .	1
..	19, 16·30...	Charles	Yorkshire	1
..	21, 16·30.	East Plean (No. 4 Pit) ...	Scotland, West .	2
..	21, 18·30...	Prestongrange ...	Scotland, East .	1
..	22, 7·0 ...	Kingswood	Southern	1
..	25, 18·0 ...	Carriden	Scotland, East	2
..	25, 20·30...	Swinhill (No. 5 Pit) ..	Scotland, West	1
..	26, 5·0 ...	Bowhill	Scotland, East ..	2
.	30, 0·30..	Whitehill (No. 2 Pit) ..	Scotland, West	2
Nov.	3, 7·30...	Kilton	Durham ...	2
,,	9, 0·15..	Burnhope	Do. ...	1
..	9, 7·30...	Morningside ...	Scotland, East .	1
..	9, 8·0 ...	Hilton	Staffordshire	1
..	9, 8·0 ...	Rheola	Swansea	2
,,	9, 13·30...	Varteg Deep Black Vein	Southern ...	1
,,	13, 7·5 ...	Canderigg (No. 1 Pit) ..	Scotland, West .	2
,,	14, 5·0 ...	Cleland	Scotland, East ..	1
..	11, 13·0 ...	Brayton	Newcastle-upon-Tyne	2
..	19, 12·0 ...	International ...	Swansea ..	2
..	25, 10·0 ...	Lochwood (No. 3 Pit)	Scotland, West ...	2
..	25, 23·30...	Roschall (No. 14 Pit) .	Do.	1
..	26, 7·30...	Walkinshaw (No. 2 Pit) ..	Do.	2
..	27, 9·30...	North Skelton	Durham	1
..	27, 15·0 ...	Belhaven	Scotland, East ..	1
Dec.	2, 7·0 ...	Bogleshole (No. 4 Pit) ...	Scotland, West ...	1
..	4, 7·30...	Meiros	Cardiff	1
..	9, 6·30...	Pollington	Midland	2
..	9, 11·0 ...	Moorfield (No. 1 Pit) ..	Scotland, West .	2
..	10, 7·30...	Toftshaw Bottom	Yorkshire	3
,,	10, 8·0 ...	Rigfoot	Scotland, West ...	1
..	11, 15·30...	Gartshore (No. 9 Pit) .	Do.	1
..	14, 2·0 ...	Fairlie (No. 3 Pit) ...	Do. .	1
..	15, 16·30..	Roschall (No. 13 Pit) ..	Do.	2
..	16, 9·15...	Butterknowle	Durham	1
..	23, 22·0 ..	Motherwell	Scotland, East	1
..	24, 19·0 ...	Sundrum (No. 3 Pit) ..	Scotland, West ...	1
..	29, 13·0 ...	Bourtrechill (Capringston No. 6 Pit)	Do.	1
..	29, 19·30 ..	Niddrie	Scotland, East .	1
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TABLE IV.—BAROMETER, THERMOMETER, ETC., READINGS, 1903.

JANUARY, 1903.

Date.	KEW. BAROMETER. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	TEMPERATURE. Max	Min.	Direction of wind at noon.	Date.	GLASGOW. BAROMETER. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	TEMPERATURE. Max	Min.	Direction of wind at noon.
1	29·538	29·622	29·667	29·660	38·3	29·8	W	1	29·408	29·427	29·406	29·300	39·1	29·0	SSW
2	29·575	29·395	29·388	29·382	51·1	31·8	SW	2	29·107	29·059	29·079	29·048	42·5	37·3	WSW
3	29·494	29·462	29·601	29·732	49·7	40·0	SW	3	28·964	29·006	29·093	29·194	42·1	36·3	W
4	29·752	29·808	29·772	29·633	47·2	30·9	SW	4	29·245	29·272	29·400	29·495	45·2	38·1	WSW
5	29·649	29·654	29·642	29·640	53·6	44·4	WSW	5	29·542	29·544	29·474	29·316	42·6	37·2	E
6	29·542	29·486	29·387	29·346	52·4	50·5	SW	6	29·096	28·952	29·013	28·984	44·9	37·0	W
7	29·277	29·302	29·393	29·573	50·9	41·7	SW	7	28·776	28·812	29·034	29·268	43·6	35·7	W
8	29·668	29·730	29·648	29·590	44·5	34·6	SW	8	29·416	29·555	29·570	29·522	36·5	31·2	W
9	29·478	29·412	29·303	29·296	51·4	44·0	S	9	29·309	29·271	29·077	28·979	35·2	31·4	E
10	29·318	29·385	29·377	29·391	50·7	34·1	WSW	10	28·993	29·299	29·521	29·683	37·2	30·2	NE
11	29·475	29·661	29·777	29·929	38·6	32·0	N	11	29·748	29·866	29·983	30·102	34·6	26·8	W
12	30·016	30·152	30·223	30·299	36·1	29·6	NNE	12	30·170	30·266	30·327	30·390	32·2	24·6	SSE
13	30·325	30·413	30·455	30·486	32·6	27·0	NE	13	30·424	30·474	30·502	30·548	28·7	17·9	NNE
14	30·507	30·550	30·505	30·490	32·7	28·9	E	14	30·557	30·552	30·506	30·514	32·3	19·6	E
15	30·453	30·438	30·389	30·389	33·1	26·9	E	15	30·509	30·495	30·421	30·343	31·6	22·1	ENE
16	30·360	30·330	30·221	30·176	32·2	25·0	ESE	16	30·258	30·179	30·085	30·050	33·4	29·1	ESE
17	30·124	30·129	30·115	30·134	34·2	26·3	E	17	30·026	30·068	30·074	30·094	32·9	28·8	ESE
18	30·113	30·135	30·152	30·189	39·0	34·4	E	18	30·050	30·068	30·073	30·099	35·8	31·3	E
19	30·173	30·184	30·175	30·192	42·3	37·8	E	19	30·094	30·132	30·124	30·162	39·1	34·0	E
20	30·206	30·270	30·273	30·295	43·7	35·3	ESE	20	30·202	30·267	30·245	30·221	37·4	33·4	E
21	30·274	30·316	30·290	30·285	41·7	35·2	SE	21	30·145	30·095	30·026	29·956	43·1	35·8	S
22	30·195	30·103	29·926	29·851	45·3	38·7	S	22	29·825	29·651	29·581	29·635	43·7	35·9	WSW
23	29·979	30·057	30·121	30·165	45·4	33·4	W	23	29·605	29·762	29·800	29·710	42·8	35·2	WSW
24	30·115	30·075	30·052	30·088	48·2	38·0	SW	24	29·483	29·639	29·723	29·692	46·1	40·9	SW
25	30·070	30·064	30·011	30·094	49·2	46·9	SW	25	29·496	29·361	29·404	29·697	50·7	41·0	SW
26	30·148	30·192	30·178	30·175	51·6	46·9	SW	26	29·589	29·597	29·620	29·608	51·8	44·1	SW
27	30·121	30·113	30·046	30·009	52·3	44·8	SW	27	29·606	29·642	29·665	29·672	47·7	40·4	WSW
28	30·021	30·115	30·118	30·202	48·6	39·8	WSW	28	29·596	29·564	29·586	29·800	44·3	39·8	WSW
29	30·293	30·385	30·326	30·302	48·9	39·5	WSW	29	29·920	29·862	29·703	29·758	46·4	40·3	WSW
30	30·268	30·276	30·237	30·190	49·7	45·5	WSW	30	29·739	29·760	29·736	29·697	48·3	45·7	WSW
31	30·092	29·967	29·763	29·511	46·5	41·0	S	31	29·621	29·505	29·261	29·031	47·3	43·3	SW

FEBRUARY, 1903.

1	29·218	29·347	29·315	29·388	46·7	32·1	W	1	28·823	28·921	29·081	29·368	45·3	33·3	WSW
2	29·620	29·903	30·082	30·237	42·0	31·6	N	2	29·676	29·906	29·999	29·967	40·4	33·8	W
3	30·266	30·302	30·317	30·358	47·1	32·5	W	3	29·973	30·029	30·076	30·050	48·3	40·0	WSW
4	30·364	30·393	30·363	30·372	47·7	45·0	WSW	4	30·015	29·974	29·942	29·963	49·1	45·6	WSW
5	30·349	30·369	30·321	30·272	47·4	41·0	SW	5	29·976	29·996	29·941	29·881	49·4	46·0	SW
6	30·133	30·054	29·957	30·029	49·5	40·9	SSW	6	29·769	29·623	29·391	29·625	49·0	40·4	S
7	30·016	30·053	29·980	30·016	52·5	44·6	SW	7	29·651	29·487	29·209	29·385	52·9	39·1	SW
8	30·051	30·126	30·144	30·224	54·3	50·4	SW	8	29·509	29·561	29·663	29·807	52·6	40·6	W
9	30·263	30·336	30·449	30·595	55·8	49·2	W	9	29·874	30·073	30·286	30·313	50·8	38·5	W
10	30·595	30·620	30·538	30·539	54·6	46·0	SW	10	30·208	30·144	30·048	30·117	51·5	46·2	SW
11	30·494	30·506	30·430	30·416	54·2	44·1	WSW	11	30·151	30·220	30·228	30·190	48·4	42·9	WSW
12	30·347	30·291	30·256	30·371	53·4	39·3	WNW	12	30·139	30·171	30·255	30·349	47·3	39·1	W
13	30·424	30·472	30·395	30·358	46·6	35·5	WNW	13	30·381	30·344	30·187	30·097	46·6	35·1	SW
14	30·226	30·130	30·041	30·030	49·3	36·5	W	14	29·957	29·917	29·900	29·899	49·2	44·5	WSW
15	30·007	30·020	30·051	30·137	47·7	43·9	NW	15	29·908	29·953	30·043	30·143	46·9	39·9	ESE
16	30·213	30·350	30·436	30·573	44·8	34·2	E	16	30·196	30·282	30·326	30·380	44·5	39·3	E
17	30·597	30·638	30·555	30·564	45·1	29·7	SSW	17	30·348	30·339	30·305	30·300	48·4	41·8	SW
18	30·530	30·525	30·440	30·435	47·7	25·4	S	18	30·261	30·231	30·098	30·006	47·1	42·6	SW
19	30·355	30·317	30·247	30·213	54·4	36·5	SW	19	29·808	29·695	29·578	29·589	53·3	44·4	SW
20	30·192	30·393	30·367	30·201	57·3	48·4	WSW	20	29·672	30·030	29·799	29·530	50·6	41·2	SW
21	30·104	30·079	29·905	30·171	55·9	45·1	SW	21	29·536	29·514	29·496	29·672	52·1	38·2	W
22	30·181	30·017	29·827	29·673	53·9	43·0	SW	22	29·708	29·619	29·208	29·130	50·7	36·8	SSW
23	29·670	29·706	29·759	29·951	50·9	36·0	W	23	29·139	29·210	29·315	29·537	44·1	33·3	W
24	30·005	29·920	29·718	29·577	49·0	35·3	SSW	24	29·497	29·259	28·964	28·988	47·3	34·6	SW
25	29·618	29·799	29·784	29·692	52·2	44·3	SW	25	29·091	29·241	29·249	29·092	43·3	37·6	SW
26	29·526	29·707	29·867	29·788	49·2	40·6	WSW	26	29·087	29·225	29·431	29·291	43·8	35·2	WSW
27	29·379	29·496	29·473	29·460	51·1	43·2	SW	27	28·431	28·641	29·096	29·260	44·2	36·2	W
28	29·382	29·441	29·657	29·872	46·1	37·5	NW	28	29·314	29·377	29·381	29·479	41·5	34·1	SW

MARCH, 1903.

KEW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	29·853	29·639	29·388	29·537	48·6	35·6	S
2	29·521	29·137	28·809	28·756	51·0	35·0	SSW
3	28·824	29·179	29·514	29·761	47·4	37·8	NW
4	29·844	29·804	29·774	29·840	53·7	34·3	SW
5	29·705	29·777	29·844	29·923	50·3	39·2	WNW
6	30·001	30·127	30·132	30·144	48·1	34·3	W
7	30·002	29·820	29·885	30·053	45·2	36·5	WSW
8	30·179	30·285	30·320	30·353	47·6	33·7	NW
9	30·270	30·170	30·047	29·974	49·1	31·8	SSW
10	29·908	29·933	29·914	29·963	45·1	33·6	SSW
11	29·958	29·984	29·937	29·961	49·3	28·2	WSW
12	29·924	29·933	29·901	29·937	52·6	30·7	S
13	29·905	29·918	29·882	29·906	56·0	35·6	S
14	29·857	29·875	29·855	29·873	53·8	37·3	SE
15	29·837	29·794	29·718	29·700	50·8	30·1	SW
16	29·603	29·663	29·755	29·869	50·2	37·5	SW
17	29·855	29·778	29·642	29·551	51·0	37·5	S
18	29·416	29·736	29·987	30·097	51·6	42·9	W
19	30·061	30·084	30·107	30·183	53·1	45·5	SW
20	30·159	30·186	30·192	30·255	55·9	48·9	SW
21	30·212	30·181	30·106	30·089	55·4	47·6	S
22	30·059	30·088	30·016	29·974	60·6	49·1	SW
23	29·886	29·789	29·691	29·556	58·8	41·1	SW
24	29·750	29·811	29·790	29·741	53·2	40·1	S
25	29·552	29·453	29·302	29·259	65·3	46·2	S
26	29·284	29·381	29·423	29·421	56·8	43·0	S
27	29·356	29·381	29·500	29·622	53·4	45·6	NW
28	29·513	29·548	29·507	29·754	57·0	43·9	SW
29	29·934	30·060	30·062	30·009	54·5	41·1	WSW
30	29·814	29·831	29·803	29·851	51·7	43·4	W
31	29·989	30·110	30·157	30·157	53·3	41·6	NNW

GLASGOW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon
1	29·316	29·004	29·014	29·133	42·8	35·9	SW
2	29·084	28·805	28·561	28·646	37·2	32·1	E
3	28·952	29·222	29·450	29·536	45·7	33·8	W
4	29·384	29·319	29·393	29·410	46·2	37·6	W
5	29·434	29·526	29·576	29·640	40·1	32·9	WSW
6	29·682	29·732	29·789	29·805	40·4	34·1	WSW
7	29·705	29·681	29·768	29·879	39·6	33·0	N
8	30·050	30·139	30·078	29·963	44·8	33·7	SW
9	29·748	29·637	29·685	29·739	47·9	39·0	WSW
10	29·735	29·774	29·742	29·700	44·9	34·9	SW
11	29·634	29·659	29·625	29·606	50·6	40·1	SW
12	29·562	29·642	29·663	29·706	46·5	38·5	SW
13	29·674	29·727	29·781	29·901	46·1	35·6	SW
14	29·963	30·049	30·000	29·947	45·1	33·1	NE
15	29·804	29·671	29·488	29·444	44·1	33·1	E
16	29·340	29·275	29·306	29·419	43·1	37·9	ESE
17	29·206	29·174	29·272	29·354	45·8	38·9	WSW
18	29·320	29·424	29·489	29·445	44·3	34·6	SW
19	29·395	29·500	29·512	29·538	49·1	43·3	SW
20	29·566	29·722	29·778	29·822	46·9	40·1	WSW
21	29·687	29·629	29·519	29·424	51·5	42·3	SSW
22	29·473	29·461	29·470	29·482	53·6	43·0	SW
23	29·355	29·281	29·315	29·412	44·1	36·1	W
24	29·462	29·531	29·469	29·358	48·9	36·8	SW
25	29·173	29·011	28·973	28·953	53·7	44·6	S
26	28·990	28·999	28·913	29·127	48·1	41·0	SSE
27	29·179	29·202	29·219	29·265	46·6	40·1	WSW
28	29·154	28·859	28·997	29·287	50·3	40·4	SW
29	29·461	29·616	29·617	29·373	47·5	36·1	SW
30	29·320	29·172	29·372	29·684	46·1	36·6	SW
31	29·914	30·043	30·048	30·019	52·9	40·7	W

APRIL, 1903.

1	30·068	30·013	29·863	29·776	51·1	40·6	WSW	1	29·910	29·821	29·784	29·816	49·6	40·1	NE
2	29·778	29·859	29·898	29·997	49·0	42·0	NNW	2	29·850	29·918	29·918	29·928	48·1	35·7	W
3	30·048	30·096	30·022	29·977	53·6	35·3	W	3	29·852	29·750	29·642	29·569	49·1	38·1	SSW
4	29·884	29·847	29·741	29·871	54·8	43·2	WSW	4	29·419	29·541	29·603	29·756	49·1	37·6	W
5	29·951	30·080	30·086	30·131	52·6	40·9	NW	5	29·831	29·923	29·952	29·923	49·1	37·1	WNW
6	30·096	30·061	29·953	29·912	54·6	40·0	WSW	6	29·747	29·641	29·565	29·534	52·8	43·1	W
7	29·807	29·785	29·766	29·821	53·6	46·5	WNW	7	29·470	29·537	29·639	29·819	48·1	39·4	NW
8	29·940	30·077	30·074	30·148	55·0	39·6	N	8	29·965	30·077	30·114	30·157	54·1	39·9	NW
9	30·147	30·203	30·224	30·264	49·9	38·0	N	9	30·163	30·185	30·177	30·204	52·9	42·8	W
10	30·282	30·309	30·258	30·268	53·7	35·7	N	10	30·200	30·198	30·092	29·963	51·3	44·3	WSW
11	30·187	30·105	29·986	29·943	52·0	45·9	W	11	29·846	29·740	29·712	29·776	49·4	37·4	W
12	29·989	30·009	29·955	29·961	49·1	36·9	WNW	12	29·857	29·856	29·821	29·829	43·1	33·6	W
13	29·908	29·871	29·847	29·918	45·4	33·7	NW	13	29·785	29·789	29·801	29·843	44·3	30·4	NW
14	29·940	30·000	30·025	30·021	48·3	31·9	NW	14	29·859	29·902	29·869	29·785	42·1	31·6	W
15	29·855	29·927	29·942	30·069	47·1	33·8	NNW	15	29·859	29·963	30·018	30·133	43·1	27·6	NNW
16	30·113	30·166	30·184	30·178	44·4	30·9	N	16	30·187	30·247	30·268	30·335	42·1	31·4	NNW
17	30·304	30·324	30·302	30·364	45·1	30·2	N	17	30·370	30·387	30·376	30·438	42·3	30·3	NNW
18	30·372	30·384	30·283	30·317	48·9	30·1	NW	18	30·383	30·353	30·276	30·286	47·2	29·6	WNW
19	30·304	30·259	30·116	30·070	53·0	30·0	N	19	30·237	30·191	30·091	30·027	52·5	34·2	W
20	29·994	29·914	29·762	29·694	54·0	30·0	W	20	29·929	29·835	29·722	29·727	49·1	34·4	W
21	29·567	29·531	29·507	29·520	48·1	37·3	NNE	21	29·701	29·688	29·649	29·663	44·9	34·9	NE
22	29·473	29·467	29·441	29·486	48·9	34·9	NE	22	29·635	29·604	29·534	29·510	44·1	30·6	W
23	29·454	29·476	29·491	29·583	46·9	32·5	NNE	23	29·482	29·538	29·608	29·738	46·7	34·1	E
24	29·601	29·631	29·646	29·682	47·8	35·1	N	24	29·741	29·746	29·687	29·676	53·8	30·1	NNW
25	29·660	29·656	29·578	29·590	57·0	32·5	W	25	29·599	29·541	29·488	29·522	56·0	32·8	S
26	29·558	29·485	29·357	29·315	48·0	42·4	S	26	29·498	29·491	29·446	29·447	49·5	37·8	ESE
27	29·249	29·286	29·360	29·445	58·0	45·9	S	27	29·384	29·361	29·313	29·341	46·8	39·3	E
28	29·497	29·563	29·530	29·430	59·6	45·1	SW	28	29·347	29·387	29·408	29·424	52·1	40·9	S
29	29·245	29·338	29·378	29·396	59·8	48·6	SW	29	29·384	29·336	29·310	29·293	51·1	41·9	E
30	29·384	29·430	29·415	29·385	59·0	47·6	SSW	30	29·283	29·330	29·343	29·417	55·3	43·1	N

MAY, 1903.

KEW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	29·362	29·395	29·408	29·562	56·4	46·6	SE
2	29·618	29·642	29·638	29·587	60·1	45·4	S
3	29·453	29·452	29·412	29·357	53·7	48·6	S
4	29·246	29·224	29·183	29·183	63·3	48·7	SW
5	29·198	29·216	29·234	29·345	59·6	42·8	S
6	29·489	29·461	29·456	29·518	60·5	49·6	SSW
7	29·547	29·613	29·643	29·706	58·3	42·8	SW
8	29·674	29·685	29·653	29·686	55·5	38·3	E
9	29·678	29·695	29·674	29·704	57·8	46·0	E
10	29·692	29·730	29·710	29·745	57·1	45·0	NW
11	29·742	29·790	29·767	29·816	50·6	42·8	N
12	29·816	29·842	29·832	29·886	53·0	39·9	NNE
13	29·879	29·867	29·847	29·898	58·0	34·9	W
14	29·931	30·011	30·064	30·128	59·0	48·4	WSW
15	30·134	30·141	30·125	30·176	60·0	47·9	SW
16	30·208	30·181	30·083	29·943	55·4	43·6	W
17	29·715	29·682	29·739	29·933	53·9	44·9	W
18	30·046	30·109	30·045	30·045	58·3	39·9	N
19	30·015	29·986	29·934	29·948	62·3	38·2	SW
20	29·941	29·949	29·951	30·043	64·1	42·3	SW
21	30·088	30·161	30·164	30·193	69·9	47·8	WSW
22	30·163	30·119	30·055	30·120	75·0	47·8	S
23	30·247	30·354	30·351	30·405	66·6	50·3	NNE
24	30·390	30·382	30·327	30·320	62·1	44·5	E
25	30·303	30·298	30·233	30·293	68·2	40·5	NE
26	30·276	30·257	30·209	30·213	67·6	46·7	NE
27	30·177	30·134	30·041	30·034	68·5	47·6	NE
28	29·930	29·869	29·788	29·801	65·6	55·2	SE
29	29·777	29·748	29·702	29·745	69·2	53·7	E
30	29·734	29·734	29·724	29·743	75·6	56·0	SE
31	29·715	29·770	29·738	29·780	74·3	57·2	N

GLASGOW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	29·440	29·490	29·470	29·505	52·2	44·6	E
2	29·507	29·495	29·472	29·488	52·3	43·1	E
3	29·460	29·427	29·384	29·388	48·6	43·3	E
4	29·356	29·373	29·311	29·242	48·6	42·1	E
5	29·183	29·261	29·275	29·371	48·5	43·4	E
6	29·397	29·454	29·472	29·507	49·1	42·7	N
7	29·505	29·535	29·547	29·605	48·1	41·3	SSE
8	29·630	29·697	29·700	29·761	51·6	41·8	E
9	29·779	29·809	29·798	29·850	53·3	39·1	E
10	29·850	29·885	29·895	29·947	48·9	41·2	ESE
11	29·933	29·908	29·841	29·837	50·3	39·9	NW
12	29·819	29·837	29·791	29 758	55·1	37·7	WNW
13	29·656	29·540	29·468	29·454	52·5	44·1	SW
14	29·494	29·614	29·733	29·726	49·8	44·3	W
15	29·691	29·798	29·894	29·944	52·1	43·6	W
16	29·885	29·827	29·685	29·604	52·0	43·8	WSW
17	29·611	29·774	29·845	29·942	55·0	44·1	E
18	29·982	30·019	29·989	29·986	52·1	39·1	NNE
19	29·961	29·929	29·859	29·850	56·1	39·3	SW
20	29·794	29·736	29·763	29·802	56·1	41·0	WSW
21	29·789	29·880	29·975	29·988	57·4	48·8	WNW
22	29·944	29·868	29·797	30·060	59·2	47·6	SW
23	30·217	30·322	30·364	30·379	57·9	43·3	WSW
24	30·373	30·355	30·300	30·276	67·0	46·9	SW
25	30·278	30·283	30·282	30·316	69·2	45·6	E
26	30·357	30·380	30·340	30·348	73·1	47·3	ENE
27	30·357	30·331	30·257	30·255	69·1	46·1	E
28	30·215	30·123	30·005	29·979	69·5	44·3	ENE
29	29·936	29·880	29·845	29·861	65·9	47·9	E
30	29·842	29·828	29·779	29·815	55·9	46·3	ENE
31	29·812	29·837	29·828	29·845	67·8	48·4	W

JUNE, 1903.

1	29·772	29·778	29·741	29·833	78·7	51·6	N
2	29·878	29·984	30·046	30·153	60·5	45·7	NNE
3	30·203	30·257	30·281	30·346	55·1	43·5	NE
4	30·354	30·373	30·342	30·374	65·6	42·0	NE
5	30 343	30·306	30·293	30·346	66·7	48·5	NE
6	30·341	30·365	30·302	30·323	61·3	46·8	NE
7	30·296	30·284	30·213	30·212	57·3	45·8	NE
8	30·171	30·134	30·014	29·898	63·1	48·7	NE
9	29·785	29·768	29·740	29·793	65·6	50·5	ENE
10	29·759	29·771	29·731	29·755	59·3	55·2	E
11	29·756	29·829	29·894	29·961	55·7	48·5	N
12	29·985	30·031	30·048	30·069	54·0	42·0	NNE
13	30·019	29·942	29·890	29·853	58·0	39·6	SW
14	29·807	29·806	29·763	29·740	51·6	45·0	NE
15	29·678	29·673	29·625	29·579	51·1	47·3	NE
16	29·552	29·588	29·610	29·665	56·9	46·0	ENE
17	29·677	29·713	29·647	29·677	66·2	46·5	W
18	29·690	29·677	29·623	29·625	58·2	43·5	NNE
19	29·581	29·544	29·539	29·622	50·2	46·7	NE
20	29·669	29·798	29·887	30·011	52·8	45·6	NNE
21	30·075	30·148	30·163	30·221	60·4	45·4	NNE
22	30·222	30·245	30·201	30·228	66·5	41·4	S
23	30·197	30·169	30·093	30·047	67·2	44·3	SE
24	29·963	29·970	29·967	30·011	68·1	54·4	ESE
25	30·039	30·098	30·080	30·138	71·2	51·0	WNW
26	30·159	30·180	30·166	30·165	73·9	55·0	SSW
27	30·119	30·093	30·052	30·031	80·8	55·4	SSW
28	29·975	30·007	30·037	30·108	80·0	61·0	W
29	30·158	30·205	30·196	30·255	71·8	55·2	WNW
30	30·268	30·315	30·299	30·309	71·9	53·8	W

1	29·847	29·848	29·863	29·943	59 0	48·6	W
2	30·021	30·074	30·124	30·227	58·5	42·8	WNW
3	30·290	30·337	30·325	30·356	65·6	43·2	NW
4	30·374	30·385	30·354	30 347	68·4	47·4	NW
5	30·345	30·348	30·333	30·382	69·3	53·1	NE
6	30·397	30·386	30·326	30·349	75·1	51·1	SSE
7	30·374	30·375	30·316	30·344	68·4	52·3	ESE
8	30·338	30·332	30·263	30·262	65·3	49·5	E
9	30·201	30·136	30·016	30·009	63·4	45·6	E
10	29·946	29·922	29·914	29·946	64·7	49·3	ESE
11	29·964	29·989	29·982	30·047	59·2	48·3	E
12	30·049	30·041	29·981	29·968	59·6	43·1	NW
13	29·970	30·002	29·964	30·030	57·3	46·5	SE
14	30·050	30·065	30·058	30·055	58·7	41·5	E
15	30·004	29·955	29·869	29·849	61·4	45·1	NE
16	29·775	29·781	29·786	29·797	53·1	48·7	E
17	29·758	29·725	29·702	29·721	53·1	47·1	E
18	29·712	29·710	29·685	29·683	53·4	44·1	N
19	29·668	29·695	29·748	29·850	55·4	45·2	ESE
20	29·905	29·968	29·974	30·024	59·2	49·1	W
21	30·058	30·079	30·087	30·119	64·1	41·3	WSW
22	30·118	30·128	30·105	30·118	65·2	51·0	SW
23	30·074	30·071	30·014	29·992	61·2	50·3	SSE
24	29·952	29·940	29·906	29·938	62·4	49·5	S
25	29·938	29·972	29·993	30·027	66·0	53·6	SSW
26	29·997	29·962	29·935	29·897	59·2	54·2	SE
27	29·893	29·943	29·927	29·870	60·9	56·4	WNW
28	29·775	29·813	29·935	29·975	65·7	57·4	WNW
29	29·934	29·936	30·020	30·112	61·9	54·4	W
30	30·127	30·128	30·113	30·078	62·8	51·3	W

JULY, 1903.

KEW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	30·299	30·295	30·204	30·204	76·9	53·2	W
2	30·126	30·050	29·913	29·843	79·9	52·8	S
3	29·921	30·016	30·031	30·086	69·7	54·6	NW
4	30·089	30·126	30·087	30·055	70·4	51·3	W
5	30·008	29·963	29·823	29·755	70·2	56·7	S
6	29·684	29·767	29·832	29·939	63·7	52·1	WNW
7	30·006	30·036	30·062	30·150	64·2	47·1	NW
8	30·196	30·207	30·181	30·214	69·3	46·3	N
9	30·216	30·256	30·263	30·295	76·1	61·7	N
10	30·298	30·292	30·211	30·207	83·2	60·0	WSW
11	30·171	30·140	30·045	30·001	83·3	60·3	SW
12	29·927	29·921	29·887	29·880	67·5	54·0	N
13	29·873	29·906	29·906	29·948	64·4	47·8	NW
14	29·956	29·961	29·921	29·931	68·8	48·4	W
15	29·881	29·867	29·821	29·821	75·0	54·6	WSW
16	29·709	29·705	29·627	29·588	66·4	55·8	S
17	29·553	29·561	29·544	29·585	71·5	56·9	SSW
18	29·568	29·583	29·632	29·725	68·0	56·7	W
19	29·768	29·818	29·847	29·890	67·2	54·7	NW
20	29·917	29·981	30·030	30·099	61·6	55·4	NNE
21	30·099	30·099	30·038	30·007	69·7	49·0	SW
22	29·930	29·898	29·823	29·810	72·0	61·1	SW
23	29·748	29·728	29·657	29·638	65·8	55·1	W
24	29·659	29·787	29·857	29·969	69·2	52·4	W
25	29·980	29·982	29·909	29·840	68·8	48·2	S
26	29·736	29·742	29·778	29·891	69·7	55·1	W
27	29·904	29·846	29·688	29·649	63·7	48·1	S
28	29·679	29·665	29·532	29·530	64·5	56·3	S
29	29·573	29·621	29·633	29·615	65·1	54·1	W
30	29·576	29·668	29·774	29·838	63·4	52·5	NW
31	29·836	29·902	29·953	30·017	62·0	54·5	W

GLASGOW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	30·042	30·060	30·041	30·051	66·8	54·8	W
2	30·032	29·966	29·794	29·602	71·3	51·8	SW
3	29·663	29·680	29·683	29·714	62·7	52·6	W
4	29·766	29·870	29·931	29·930	60·2	52·1	W
5	29·821	29·687	29·525	29·405	57·2	52·8	SW
6	29·534	29·708	29·849	29·960	59·0	48·3	N
7	30·015	30·055	30·076	30·130	65·3	43·6	NW
8	30·121	30·104	30·094	30·136	62·1	46·6	W
9	30·162	30·208	30·190	30·168	70·9	55·8	WNW
10	30·160	30·160	30·132	30·124	63·2	57·6	W
11	30·145	30·131	30·070	30·050	64·2	49·1	WNW
12	29·990	29·942	29·890	29·867	59·5	46·4	NW
13	29·822	29·838	29·834	29·855	61·7	48·1	NW
14	29·847	29·840	29·793	29·748	61·5	43·9	WSW
15	29·646	29·670	29·703	29·727	57·1	50·2	ESE
16	29·683	29·620	29·524	29·484	56·9	52·7	E
17	29·454	29·495	29·529	29·608	57·5	53·3	ESE
18	29·612	29·682	29·694	29·780	61·1	51·0	E
19	29·814	29·860	29·876	29·902	61·8	49·5	ENE
20	29·942	29·974	29·978	29·992	64·5	49·6	W
21	29·950	29·893	29·806	29·761	61·0	45·3	SSW
22	29·678	29·659	29·652	29·657	66·0	56·5	WSW
23	29·608	29·637	29·624	29·671	67·5	54·4	W
24	29·676	29·708	29·721	29·811	67·3	48·4	W
25	29·842	29·839	29·731	29·639	69·1	51·1	S
26	29·614	29·669	29·683	29·731	66·1	55·9	WNW
27	29·717	29·714	29·650	29·632	60·0	50·4	N
28	29·604	29·588	29·570	29·548	56·1	52·8	E
29	29·492	29·480	29·481	29·538	63·4	50·3	W
30	29·575	29·609	29·675	29·738	64·0	50·9	W
31	29·753	29·806	29·838	29·862	61·2	53·2	WNW

AUGUST, 1903.

1	30·018	30·018	29·965	29·977	70·9	54·5	SW
2	29·962	29·963	29·902	29·847	67·3	56·0	W
3	29·635	29·657	29·787	29·907	69·1	56·0	NW
4	29·926	29·890	29·862	29·926	70·0	54·5	SW
5	29·963	30·013	30·035	30·127	67·5	54·1	W
6	30·161	30·205	30·179	30·192	67·1	50·4	WNW
7	30·179	30·162	30·095	30·068	70·5	46·9	SW
8	29·972	29·865	29·731	29·732	76·3	49·1	SSE
9	29·758	29·785	29·732	29·718	69·4	55·8	SW
10	29·623	29·591	29·769	29·888	66·0	52·8	WSW
11	29·9.2	29·909	29·829	29·685	64·0	46·1	S
12	29·711	29·860	29·884	29·919	69·0	55·0	W
13	29·917	29·941	29·884	29·831	71·2	50·1	W
14	29·616	29·437	29·292	29·246	69·7	53·4	S
15	29·193	29·246	29·405	29·559	64·3	56·0	WSW
16	29·675	29·783	29·832	29·834	65·0	52·2	W
17	29·652	29·613	29·683	29·727	69·3	55·5	W
18	29·504	29·480	29·601	29·612	63·3	54·2	NW
19	29·589	29·682	29·774	29·856	66·6	53·3	NW
20	29·811	29·769	29·588	29·427	63·6	53·6	SW
21	29·441	29·596	29·684	29·794	65·3	52·0	W
22	29·820	29·862	29·835	29·882	67·9	48·9	WSW
23	29·864	29·834	29·742	29·789	66·0	45·0	W
24	29·775	29·679	29·620	29·605	65·2	49·6	S
25	29·604	29·771	29·981	30·143	60·2	50·7	NW
26	30·205	30·223	30·188	30·159	66·3	46·3	WSW
27	30·107	30·082	30·021	29·985	67·7	55·0	SW
28	29·976	30·015	29·967	29·848	67·3	55·2	SW
29	29·730	29·866	29·964	30·085	66·9	55·8	NW
30	30·166	30·132	30·045	29·950	64·6	52·5	SSW
31	29·895	30·019	30·057	30·084	69·8	56·3	WNW

1	29·838	29·809	29·804	29·803	61·4	50·7	WNW
2	29·789	29·796	—	29·495	62·6	51·3	W
3		29·542		29·704	60·7	53·0	WNW
4	—	29·599	29·573	29·626	61·3	52·2	W
5	29·687	29·731	29·825	29·905	60·2	52·5	WNW
6	29·905	29·920	29·935	30·001	58·7	50·8	WNW
7	30·008	30·018	29·970	29·892	62·2	49·3	WSW
8	29·733	29·664	29·492	29·368	63·3	53·0	SW
9	29·283	29·310	29·316	29·342	59·3	55·2	SW
10	29·336	29·464	29·606	29·705	59·8	50·4	WNW
11	29·744	29·755	29·735	29·748	62·1	46·0	WSW
12	29·739	29·774	29·774	29·803	63·1	48·4	WNW
13	29·768	29·788	29·779	29·716	62·7	51·3	SW
14	29·519	29·284	29·019	28·971	62·8	51·3	ESE
15	28·853	28·791	28·911	29·069	58·9	42·9	NE
16	29·127	29·389	29 564	29·620	59·5	51·1	WNW
17	29·617	29·671	29·666	29·637	61·5	46·4	WNW
18	29·552	29·554	29·527	29·546	61·4	46·3	E
19	29·549	29·577	29·591	29·569	60·3	49·7	WSW
20	29·513	29·451	29·356	29·303	58·7	47·6	SW
21	29·310	29·434	29·529	29·604	57·9	45·8	WNW
22	29·612	29·678	29·727	29·781	60·3	47·4	W
23	29·793	29·805	29·741	29·753	62·1	47·5	WNW
24	29·743	29·775	29·771	29·856	61·5	49·5	E
25	29·887	29·959	29·977	30·036	62·1	43·3	NW
26	29·950	29·872	29·761	29·735	59·8	50·2	SW
27	29·597	29·612	29·572	29·560	63·1	55·7	WSW
28	29·571	29·622	29·637	29·593	60·9	51·9	W
29	29·577	29·669	29·796	29·938	61·0	49·9	NW
30	29·961	29·913	29·584	29·334	58·9	46·0	SE
31	29·458	29·801	29·934	29·968	59·3	50·6	WNW

SEPTEMBER, 1903.

KEW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	30·099	29·950	29·926	30·023	79·0	53·4	SSW
2	29·907	29·750	29·679	29·821	78·1	57·6	S
3	29·984	30·078	30·067	30·123	68·3	52·0	SW
4	30·111	30·059	29·922	29·847	70·9	50·0	SE
5	29·754	29·798	29·876	30·015	69·0	51·4	SW
6	30·042	30·096	30·094	30·143	60·8	47·6	W
7	30·179	30·236	30·178	30·179	65·8	47·1	WSW
8	30·133	30·113	30·031	29·873	65·0	53·9	SW
9	29·635	29·726	29·794	29·923	63·4	47·9	NW
10	29·985	29·960	29·632	28·957	57·7	44·7	WSW
11	29·149	29·445	29·501	29·543	58·6	43·7	WNW
12	29·547	29·598	29·621	29·672	56·6	40·2	NW
13	29·666	29·755	29·838	30·023	57·4	40·8	N
14	30·107	30·233	30·323	30·435	56·6	45·0	N
15	30·431	30·451	30·387	30·377	55·5	42·3	NNE
16	30·274	30·235	30·136	30·161	58·0	43·4	N
17	30·182	30·251	30·258	30·319	62·7	37·0	SSW
18	30·302	30·304	30·200	30·140	63·3	44·0	E
19	30·063	30·074	30·004	30·010	64·0	52·7	E
20	29·974	29·989	29·971	29·974	66·1	57·8	E
21	29·922	29·911	29·865	29·880	68·2	55·9	E
22	29·873	29·960	30·020	30·137	63·0	53·0	E
23	30·187	30·265	30·262	30·279	67·6	55·6	E
24	30·256	30·253	30·172	30·115	66·9	56·3	ESE
25	30·046	30·096	30·107	30·203	66·7	53·6	SW
26	30·209	30·225	30·129	30·085	66·1	53·0	W
27	29·971	29·925	29·873	29·889	66·0	53·9	SW
28	29·868	29·884	29·817	29·760	67·5	55·7	S
29	29·697	29·725	29·731	29·786	67·7	58·3	S
30	29·835	29·913	29·937	29·958	66·1	52·8	SSW

GLASGOW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	29·828	29·659	29·770	29·895	62·9	48·8	SW
2	29·911	29·875	29·741	29·647	55·9	47·6	E
3	29·653	29·713	29·814	29·908	59·8	48·7	WSW
4	29·893	29·900	29·798	29·657	62·0	50·1	S
5	29·469	29·477	29·684	29·795	60·8	52·4	W
6	29·845	29·908	29·958	30·007	59·7	49·3	WSW
7	29·978	29·885	29·764	29·774	56·5	47·1	SW
8	29·739	29·763	29·657	29·326	56·7	49·6	W
9	29·398	29·535	29·612	29·720	54·3	46·6	WNW
10	29·727	29·626	29·384	29·306	51·6	45·0	W
11	29·322	29·368	29·376	29·420	55·4	41·1	WNW
12	29·488	29·540	29·512	29·567	55·2	43·9	WNW
13	29·660	29·831	29·992	30·178	56·1	38·9	N
14	30·291	30·401	30·442	30·499	54·0	36·7	ESE
15	30·501	30·500	30·434	30·420	56·9	36·0	WSW
16	30·350	30·286	30·158	30·113	52·1	37·1	ESE
17	30·061	30·085	30·117	30·175	57·3	37·4	S
18	30·198	30·233	30·183	30·208	63·1	48·1	SSE
19	30·181	30·173	30·175	30·231	60·7	48·0	E
20	30·205	30·214	30·157	30·152	58·1	52·5	E
21	30·105	30·062	30·011	30·010	61·7	52·9	E
22	29·972	30·000	30 000	30·072	59·8	52·1	SE
23	30·092	30·154	30·142	30·143	64·1	52·6	E
24	30·127	30·159	30·123	30·105	64·1	54·3	SW
25	30·057	30·063	30·025	30·075	59·7	48·4	E
26	30·093	30·117	30·039	29·988	60·0	50·2	SW
27	29·829	29·768	29·691	29·717	62·6	51·1	SE
28	29·713	29·718	29·651	29·601	62·1	50·6	SE
29	29·491	29·553	29·576	29·602	63·3	56·7	SSW
30	29·581	29·616	29·641	29·651	60·9	54·7	SW

OCTOBER, 1903.

KEW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	29·880	29·824	29·729	29·716	65·1	50·9	W
2	29·732	29·755	29·715	29·702	63·0	51·5	WSW
3	29·695	29·673	29·708	29·737	64·3	54·5	W
4	29·644	29·639	29·749	29·792	63·5	54·5	W
5	29·592	29·544	29·563	29·653	61·9	54·1	W
6	29·702	29·658	29·489	29·593	62·5	53·3	SW
7	29·763	29·882	29·840	29·793	62·2	53·6	SW
8	29·644	29·569	29·473	29·351	62·0	54·7	SSW
9	29·463	29·535	29·600	29·746	57·6	44·6	W
10	29·825	29·890	29·859	29·820	54·7	39·8	W
11	29·706	29·569	29·401	29·286	57·1	45·3	S
12	29·151	29·011	28·945	29·016	61·3	52·2	S
13	29·230	29·476	29·589	29·687	57·8	50·0	WSW
14	29·716	29·745	29·671	29·604	58·9	49·4	SW
15	29·417	29·520	29·613	29·687	57·9	46·1	W
16	29·678	29·711	29·628	29·659	55·7	45·1	SW
17	29·640	29·784	29·936	30·012	54·9	44·9	NNW
18	30·019	30·054	30·073	30·086	52·2	45·1	NW
19	30·047	30·023	29·982	29·982	56·0	47·0	S
20	29·920	29·900	29·801	29·747	56·0	51·3	S
21	29·693	29·711	29·658	29·682	55·0	46·2	WSW
22	29·603	29·430	29·314	29·401	55·1	45·3	SSW
23	29·447	29·470	29·566	29·736	52·0	42·1	WNW
24	29·797	29·775	29·634	29·503	55·1	37·9	S
25	29·470	29·434	29·349	29·248	58·3	47·3	S
26	29·285	29·244	29·243	29·367	57·6	50·0	SW
27	29·430	29·375	29·195	29·112	57·0	44·1	SSE
28	29·023	29·136	29·375	29·464	55·6	45·9	W
29	29·515	29·576	29·571	29·579	57·0	46·7	SSW
30	29·613	29·747	29·825	29·925	54·8	41·4	W
31	29·908	30·008	29·947	29·841	53·2	38·7	SW

GLASGOW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	29·601	29·610	29·540	29·505	61·1	54·1	SSW
2	29·436	29·442	29·477	29·517	58·1	51·6	W
3	29·443	29·437	29·478	29·452	57·4	50·5	NW
4	29·368	29·433	29·465	29·411	55·7	48·5	ENE
5	29·109	29·067	29·032	29·150	55·6	50·6	SW
6	29·346	29·371	29·210	29·342	53·1	40·3	E
7	29·579	29·659	29·685	29·709	44·8	40·1	E
8	29·651	29·615	29·588	29·579	49·3	43·5	ENE
9	29·559	29·617	29·692	29·760	50·0	41·9	NE
10	29·776	29·812	29·759	29·695	49·3	35·5	SE
11	29·538	29·399	29·230	29·123	51·7	41·3	ESE
12	28·959	28·824	28·788	28·806	55·9	48·5	SSE
13	28·858	29·040	29·184	29·310	53·2	42·5	W
14	29·360	29·378	29·342	29·116	51·9	43·2	WSW
15	29·017	29·029	29·144	29·246	50·8	43·4	WNW
16	29·237	29·202	29·222	29·388	49·2	43·6	WNW
17	29·652	29·828	29·906	29·951	53·5	45·0	NW
18	29·967	29·972	29·931	29·867	48·1	39·3	NE
19	29·737	29·721	29·665	29·660	56·1	45·4	SW
20	29·623	29·590	29·516	29·481	55·7	49·3	SW
21	29·433	29·432	29·380	29·383	51·3	46·3	SW
22	29·341	29·302	29·240	29·252	49·1	44·8	NE
23	29·278	29·397	29·514	29·597	49·9	39·9	WNW
24	29·529	29·400	29·222	29·064	52·1	39·0	SW
25	29·122	29·146	29·026	28·958	52·7	46·9	SW
26	28·925	28·975	28·980	29·004	51·5	46·6	SW
27	29·109	29·226	29·230	29·034	48·2	40·4	SW
28	28·976	28·954	29·088	29·249	51·2	40·2	WSW
29	29·275	29·300	29·178	29·114	49·2	39·3	SSE
30	29·262	29·323	29·480	29·596	51·4	46·2	WNW
31	29·653	29·735	29·744	29·746	51·2	44·1	SW

NOVEMBER, 1903.

KEW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	29·841	29·895	30·062	30·134	55·4	48·9	NW
2	30·120	30·157	30·129	30·124	54·1	49·3	SSW
3	29·928	29·951	30·202	30·358	56·9	42·9	N
4	30·372	30·429	30·423	30·405	52·3	35·7	NNE
5	30·327	30·382	30·342	30·362	51·3	34·1	NE
6	30·325	30·344	30·304	30·302	52·4	37·9	E
7	30·185	30·209	30·142	30·117	48·2	32·9	E
8	30·134	30·278	30·182	30·127	49·6	33·4	S
9	30·056	29·984	30·018	30·096	55·1	34·9	WSW
10	30·111	30·127	30·137	30·187	54·6	42·0	WNW
11	30·247	30·313	30·309	30·317	54·0	40·3	WNW
12	30·295	30·269	30·228	30·215	52·2	45·4	WSW
13	30·194	30·190	30·082	29·961	54·5	38·5	SW
14	29·821	29·726	29·674	29·725	54·2	42·0	WSW
15	29·691	29·713	29·714	29·761	48·3	36·6	W
16	29·771	29·817	29·806	29·855	44·4	34·0	W
17	29·902	29·860	29·786	29·922	42·1	37·5	W
18	30·033	30·131	30·128	30·155	43·9	36·3	N
19	30·167	30·235	30·245	30·254	45·3	32·2	NNE
20	30·187	30·052	29·871	29·863	49·0	29·0	W
21	29·821	29·753	29·775	29·985	55·1	46·2	W
22	30·095	30·143	30·110	30·146	53·1	44·4	W
23	30·186	30·208	30·159	30·073	53·2	46·3	SW
24	30·048	30·159	30·223	30·282	54·0	36·7	N
25	30·256	30·234	30·145	30·103	47·0	34·0	W
26	30·095	30·113	30·115	30·122	46·5	39·7	NW
27	29·992	29·739	29·178	29·028	50·0	40·6	SW
28	29·053	29·116	29·082	29·103	46·4	42·8	WNW
29	29·186	29·268	29·289	29·300	44·1	34·1	ENE
30	29·504	29·597	29·548	29·412	35·5	31·9	NNE

GLASGOW.

Date.	Barometer. 4 A.M.	10 A.M.	4 P.M.	10 P.M.	Temperature. Max	Min.	Direction of wind at noon.
1	29·823	29·949	29·957	29·971	50·1	44·8	SSW
2	29·944	29·921	29·899	29·995	49·1	44·5	SSW
3	30·051	30·125	30·140	30·187	50·7	43·4	W
4	30·239	30·342	30·417	30·495	52·1	45·0	WNW
5	30·514	30·525	30·512	30·511	50·0	40·4	WSW
6	30·500	30·513	30·469	30·476	45·1	39·0	W
7	30·443	30·428	30·347	30·284	45·8	35·3	NE
8	30·147	30·046	29·858	29·747	50·1	44·0	SSW
9	29·711	29·717	29·704	29·748	49·5	40·8	W
10	29·739	29·857	29·944	30·066	48·3	43·8	W
11	30·115	30·170	30·153	30·094	51·0	47·2	W
12	29·927	29·879	30·001	30·035	53·3	43·1	WNW
13	29·950	29·877	29·733	29·565	53·0	40·1	SW
14	29·399	29·461	29·353	29·377	51·5	40·1	S
15	29·427	29·505	29·607	29·722	47·3	39·3	NW
16	29·741	29·790	29·857	29·904	45·3	35·3	NNW
17	29·750	29·901	29·993	30·118	44·0	36·1	NNE
18	30·157	30·180	30·162	30·150	41·3	30·7	SW
19	30·147	30·153	30·100	30·035	47·1	41·6	SW
20	29·802	29·691	29·677	29·651	48·6	43·8	NNW
21	29·488	29·453	29·685	29·829	50·8	39·7	NW
22	29·863	29·803	29·798	29·864	50·9	40·1	W
23	29·840	29·789	29·608	29·488	51·3	46·9	WSW
24	29·853	30·026	30·039	30·055	51·2	39·3	W
25	29·993	29·941	29·850	29·891	41·7	34·2	W
26	29·947	29·975	29·978	29·941	38·2	34·1	W
27	29·700	29·479	29·234	29·094	36·2	32·4	NNE
28	29·047	29·129	29·225	29·382	40·7	35·1	E
29	29·458	29·468	29·428	29·419	37·9	30·4	N
30	29·429	29·479	29·527	29·611	36·1	26·6	NNW

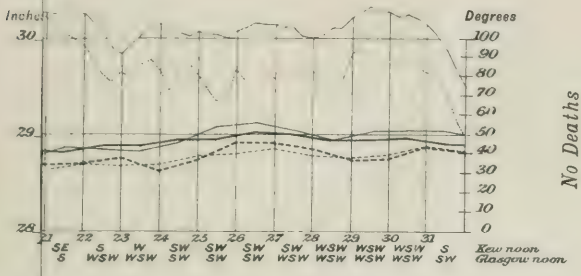
DECEMBER, 1903.

1	29·424	29·492	29·572	29·714	37·9	31·4	N	1	29·599	29·650	29·729	29·864	37·2	29·0	WNW
2	29·818	29·908	30·022	30·087	38·9	28·1	N	2	29·895	29·903	29·833	29·714	37·3	26·0	ENE
3	30·055	29·978	29·811	29·633	43·2	26·9	SW	3	29·487	29·239	29·197	29·141	47·1	36·9	WSW
4	29·447	29·421	29·378	29·360	45·7	34·2	WSW	4	29·073	29·101	29·067	29·104	41·7	34·1	W
5	29·254	29·182	29·134	29·222	45·0	25·9	W	5	29·079	29·089	29·103	29·207	37·6	32·7	S
6	29·322	29·405	29·587	29·643	35·7	28·4	NW	6	29·256	29·343	29·368	29·347	38·6	31·4	NNW
7	29·547	29·531	29·162	29·211	44·9	30·6	S	7	29·130	28·816	28·811	28·787	43·4	35·1	SW
8	29·255	29·282	29·280	29·385	47·5	37·4	SW	8	28·744	28·855	28·973	29·069	44·2	40·4	SSW
9	29·306	29·136	29·206	29·231	52·3	43·0	WSW	9	29·010	28·904	28·874	28·888	44·7	37·4	S
10	29·179	29·108	29·050	29·153	48·2	41·4	S	10	28·888	28·936	28·914	28·931	42·7	38·2	E
11	29·246	29·361	29·405	29·475	46·6	37·7	SW	11	28·948	29·020	29·094	29·182	42·9	39·0	SW
12	29·490	29·547	29·390	29·338	44·2	35·9	SE	12	29·214	29·355	29·462	29·536	41·5	35·6	S
13	29·281	29·278	29·250	29·404	48·9	43·3	SSE	13	29·462	29·415	29·362	29·331	43·1	35·2	ESE
14	29·500	29·446	29·675	29·718	47·8	38·3	S	14	29·274	29·408	29·525	29·602	46·1	42·1	SW
15	29·748	29·756	29·691	29·670	44·5	39·5	SSE	15	29·616	29·641	29·652	29·676	42·4	35·1	ESE
16	29·644	29·600	29·590	29·654	43·2	37·5	E	16	29·663	29·685	29·678	29·674	39·7	34·8	E
17	29·682	29·783	29·797	29·841	45·2	37·8	SE	17	29·641	29·636	29·676	29·760	39·3	30·4	SE
18	29·793	29·798	29·756	29·805	44·1	41·2	E	18	29·818	29·880	29·895	29·933	37·5	29·4	E
19	29·824	29·916	29·896	29·948	43·9	39·2	E	19	29·903	29·923	29·886	29·879	41·6	37·1	E
20	29·966	30·058	30·081	30·188	40·5	37·7	E	20	29·883	29·961	29·985	29·992	42·5	38·1	ENE
21	30·213	30·272	30·260	30·260	46·5	37·8	S	21	29·965	29·923	29·812	29·796	48·2	40·2	SW
22	30·236	30·228	30·165	30·126	49·6	45·2	S	22	29·736	29·691	29·728	29·774	52·3	45·2	WSW
23	30·038	30·042	29·944	29·886	46·1	37·1	S	23	29·791	29·917	29·967	29·973	46·4	39·6	WNW
24	29·856	29·886	29·919	29·970	40·5	36·8	N	24	29·962	29·984	29·979	30·022	40·2	33·1	WNW
25	29·993	30·028	30·010	30·013	41·0	37·5	N	25	30·049	30·088	30·098	30·135	38·1	29·3	SE
26	29·968	29·959	30·014	30·058	40·1	34·9	E	26	30·125	30·149	30·143	30·158	36·5	27·5	ESE
27	30·061	30·103	30·069	30·096	38·4	35·3	NE	27	30·149	30·180	30·170	30·189	38·1	33·2	ESE
28	30·105	30·156	30·120	30·107	37·5	34·4	NE	28	30·196	30·205	30·149	30·131	38·4	35·2	SE
29	30·036	30·059	30·046	30·030	36·2	30·9	ENE	29	30·082	30·129	30·145	30·205	36·8	29·9	S
30	30·069	30·075	29·964	29·932	34·2	28·0	E	30	30·189	30·163	30·049	29·994	33·4	25·4	ESE
31	29·848	29·829	29·796	29·847	31·4	27·5	E	31	29·928	29·911	29·859	29·900	37·6	31·8	ESE

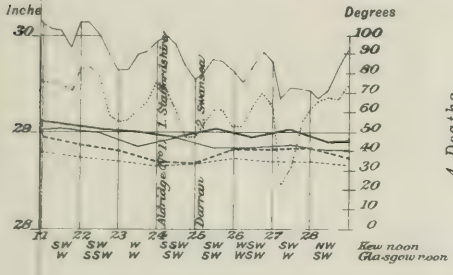
...IMA TEMPERATURES AND THE DIRECTION ...GETHER WITH THE EXPLOSIONS ...AND.

1903.

JANUARY.



FEBRUARY.



MARCH.

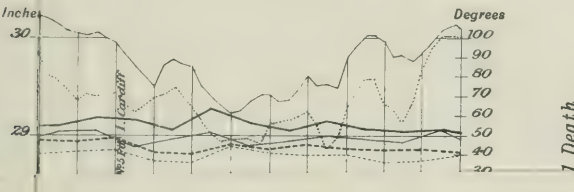
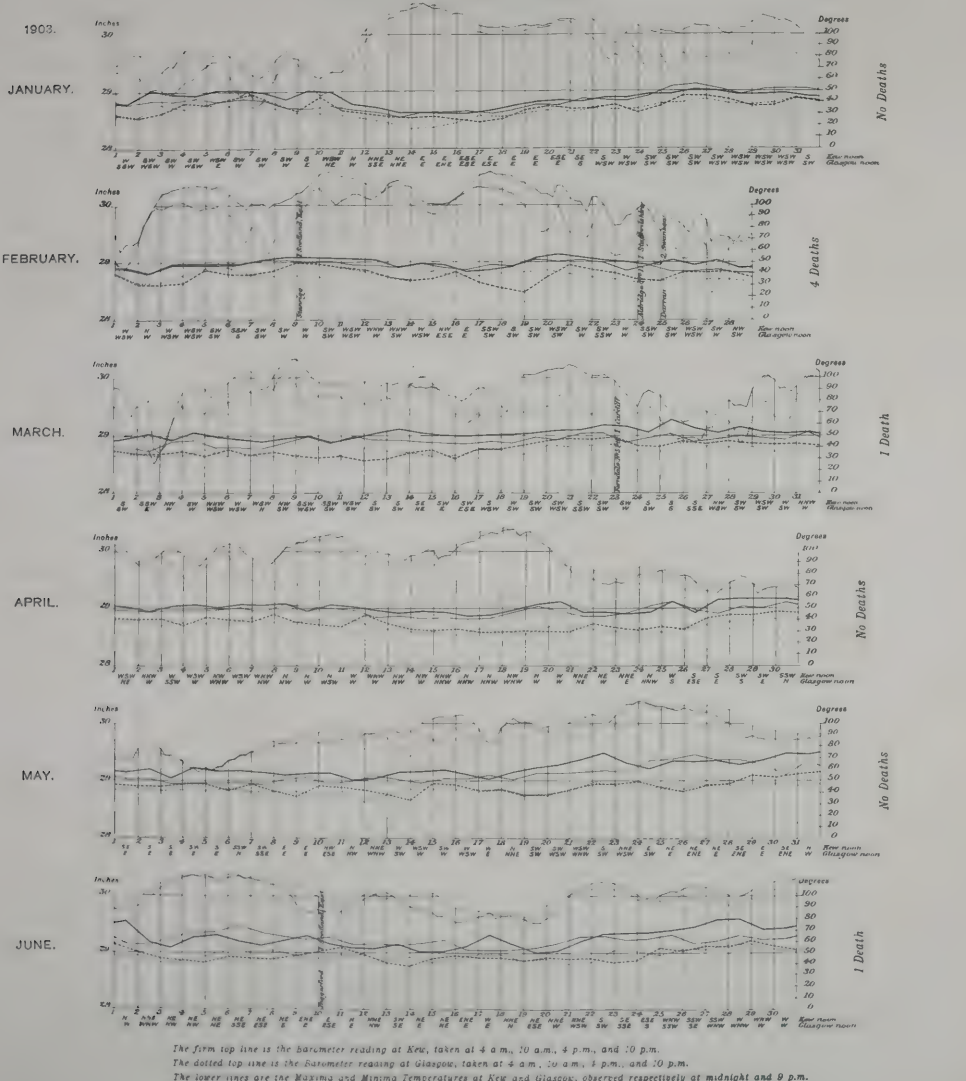


DIAGRAM SHEWING THE HEIGHT OF THE BAROMETER, THE MAXIMA AND MINIMA TEMPERATURES AND THE DIRECTION OF THE WIND AT THE OBSERVATORIES OF KEW AND GLASGOW, TOGETHER WITH THE EXPLOSIONS OF FIRE-DAMP IN ENGLAND AND SCOTLAND.



The firm top line is the Barometer reading at Kew, taken at 4 a.m., 10 a.m., 4 p.m., and 10 p.m.
The dotted top line is the Barometer reading at Glasgow, taken at 4 a.m., 10 a.m., 4 p.m., and 10 p.m.
The lower lines are the Maxima and Minima Temperatures at Kew and Glasgow, observed respectively at midnight and 9 p.m.
Kew lines are thick and Glasgow lines are thin.
The figures attached to the districts shew the Number of Deaths caused by the Explosions.

NIMA TEMPERATURES AND THE DIRECTION
OGETHER WITH THE EXPLOSIONS
LAND.

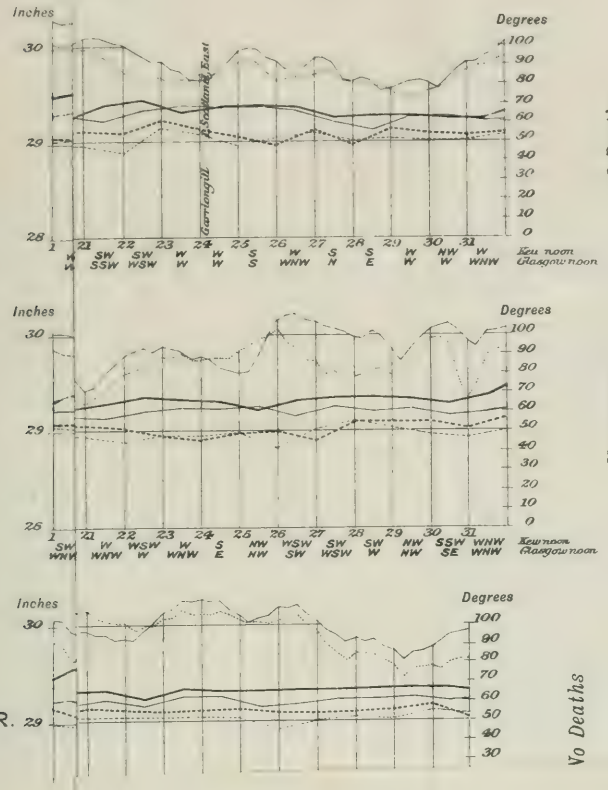
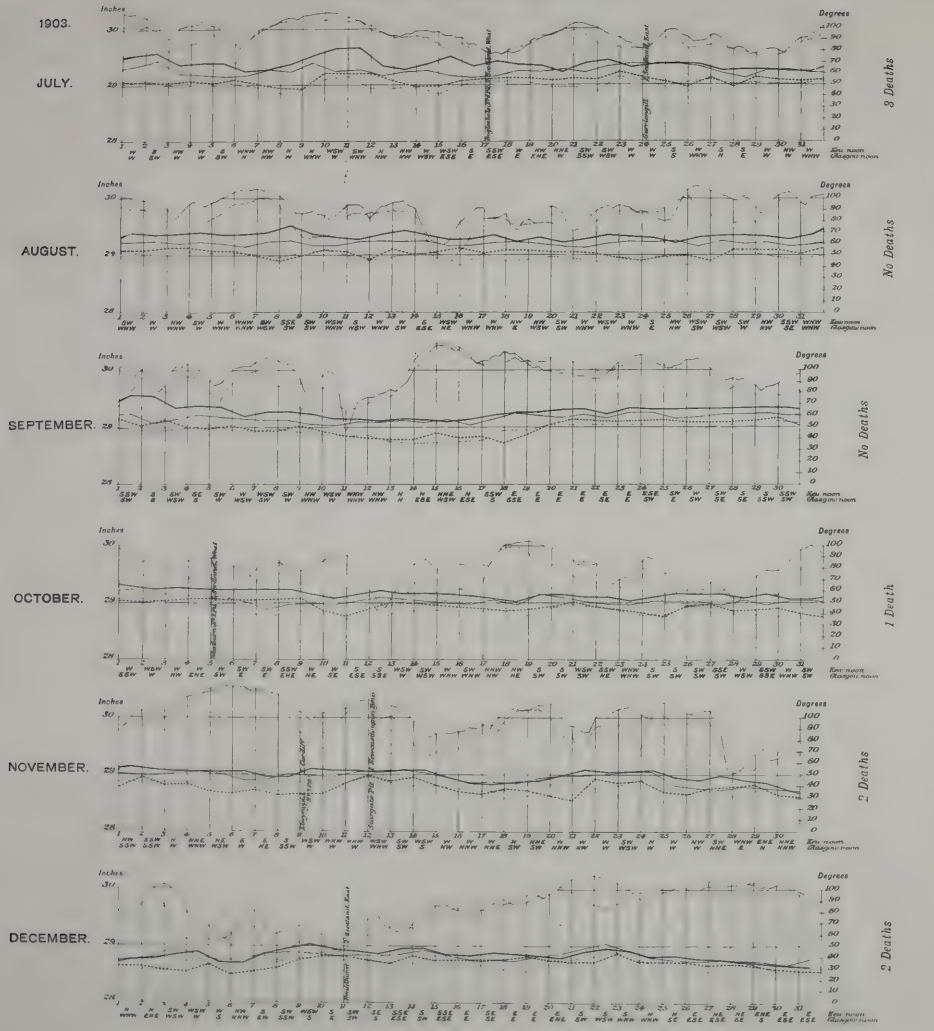


Diagram shewing the Height of the Barometer, the Maxima and Minima Temperatures and the Direction of the Wind at the Observatories of Kew and Glasgow, together with the Explosions of Fire-damp in England and Scotland.



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Discussions are printed in *italics*.

"Abs." signifies Abstracts of Foreign Papers at the end of the Proceedings.

"App." signifies Annual Report of the Council, etc., at the end of the Volume.

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